

SOLAR THERMAL POWER GENERATION  
A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE JANUARY-MARCH 1977

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## INTRODUCTION

This bibliography is the first quarterly update of 1977 of Solar Thermal Power Generation.

In an attempt to follow the continuing developments of power generation by solar thermal processes, we will include numerous related topics. These topics include; comparisons to other forms of energy, economics, legal implications and political restraints. We will also update innovations in solar thermal power generation process such as direct hydrogen production. Sizeable portions of material in this volume are in sections; 11,000 Solar Overviews, 12,000 Thermal Power, 15,000 Ocean Thermal Differential and 16, 000 Wind Conversion.

We appreciate comments or suggestions the reader would have to offer to us, so we can develop a more reader responsive publication.

Geoffrey C. Bell  
Technical Editor

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## GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

- A TABLE OF CONTENTS listing general categories of subject content and indexes. More specific coverage by subject title/keyword and author is available through the appropriate index.
- CITATION NUMBERS assigned to each reference. These numbers, with the prefix omitted, are used instead of page numbers to identify references in the various indexes. They are also used as TAC identifier numbers when dealing with document orders; so please use the entire (prefix included) citation number when corresponding with TAC regarding a reference. An open ended numbering system facilitates easy incorporation of subsequent updates into the organization of the material. In this system, numbers assigned to new citations in each category will follow directly the last assigned numbers in the previous publication. The citation number of the last reference on each page appears on the upper right-hand corner of that page to facilitate quick location of a specific term.
- A REFERENCE FORMAT containing the TAC citation number, title of reference, author, corporate affiliation, reference source, contract or grant number, abstract and keywords. The reference source tells, to the best of our knowledge, where the reference came from. If from a periodical, the reference source contains the periodical's title, volume number, page number and date. If for a report, the reference source contains the report number assigned by the issuing agency, number of pages and date.

- An INDEX OF AUTHORS alphabetized by author's last name. A reference's author is followed by the reference's citation number. For multiple authors, each author is listed in the index.
- An INDEX OF PERMUTED TITLES/KEYWORDS affords access through major words in the title and through an assigned set of keywords for each citation. A reference's title is followed by the reference's citation number. In the indexes, all the words pertaining to a reference are permuted alphabetically. Thus, the citation number for a reference appears as many times as there are major title words or keywords for that reference. The permuted words run down the center of an index page. The rest of the title or keywords appear adjacent to a permuted word. Since a title or set of keywords is allowed only one line per permuted word the beginning, the end, or both ends of a title or set of keywords may be cut off; or, if space permits, it will be continued at the opposite side of the page until it runs back into itself. A # indicates the end of a title or set of keywords while a / indicates where a title or set of keywords has been cut off within a line.

## 10,000 ENERGY OVERVIEWS

ST77 10000 AN ANALYSIS OF THE ERDA PLAN AND PROGRAM

(Office of Technology Assessment, Washington, DC), 328 p., PB-250636/8 OTA-E-12, N76-32712  
 Avail:NTIS HCS10.00

This report is an analysis of the energy research and development programs of the Energy Research and Development Administration (ERDA). The analysis was performed primarily by task groups assembled to cover each of ERDA's major programmatic areas (1) fossil energy, (2) nuclear energy; (3) solar geothermal, and advanced technologies; (4) conservation; and (5) environment and health. Since the ERDA plans reflect the President's view of national energy R and D policy, they will in large measure determine the broader options for our future national energy policy; this assessment is intended to provide the congress with much of the background information necessary for an effective analysis of the ERDA programs.

(ENERGY-OVERVIEW, ENERGY-POLICY, ENVIRONMENTAL IMPACT)

ST77 10001 ENERGY - A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA, Washington, DC), NASA-SP-7043(10), 165 p., N77-12505  
 Avail:NTIS HCS4.00

This bibliography lists 337 reports, articles, and other documents introduced into the NASA Scientific and Technical Information System from January 1, 1975 through March 31, 1975.

(ENERGY-OVERVIEW, NTIS-DATA-BASE)

ST77 10002 INSTITUTION OF ENGINEERS, AUSTRALIA, ANNUAL ENGINEERING CONFERENCE, PAPERS, 1976

Anon. (Inst of Eng, Australia, Sydney), Inst of Eng, Australia; Annu Eng Conf, Pap, Townsville, May 10-14, 1976, Publ by Inst of Eng, Australia, Sydney, 409 p., 1976

The volume contains 63 papers presented at the Conference. The papers cover subjects in a wide range of engineering disciplines, including solar and other energy resources, urban planning, dams, electric power distribution, water and air pollution, water supply, construction, computer applications, engineering education, and others.

(ENERGY-OVERVIEW)

ST77 10003 INTERNATIONAL ENERGY AGENCY WITH EMPHASIS ON THE SUBGROUP ON ENERGY RESEARCH AND DEVELOPMENT AND THE ENERGY CONSERVATION WORKING PARTY

(ERDA, Washington, DC), 38 p., ERDA-76-13, N76-34036  
 Avail:NTIS HCS4.00

Activities of the subgroup on Energy Research and Development and the working group on Energy Conservation are summarized. These include projects to explore the following (1) hydrogen from water; (2) waste heat utilization; (3) municipal and industrial waste utilization; (4) coal technology; (5) radioactive waste management; (6) nuclear safety; (7) thermonuclear fusion; (8) solar energy, and (9) energy conservation. The thermal characteristics of buildings, heat pumps, thermal storage, and heat exchangers are also studied.

(ENERGY-OVERVIEW)

ST77 10004 INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE 11TH, STATE LINE, NEVADA, SEPTEMBER 12-17, 1976

(Conference sponsored by AIChE, ANS, SAE, ACS, AIAA, ASME, and IEEE), New York, American Institute of Chemical Engineers, V 1:1007, V 2:1011, 1976, Proceedings, Volumes 1 & 2, A77-12662, Price of two volumes, members \$75.00; nonmembers \$90.00

Discussed topics are related to the areas of advanced auto propulsion, advanced concepts, alternative fuels, biomedical power, Brayton cycles and expanders, coal and oil shale utilization, electric vehicles, electrochemical power, energy conservation and storage, geothermal energy, heat pipes, and hydrogen energy systems. Attention is also given to MHD and other topping cycles, nuclear power, Rankine cycle power, solar power, space power, Stirling cycle engines, thermoelectrics, thermionics, urban energy management, and wind power. Individual items are announced in this issue.

(ENERGY-OVERVIEW, ALTERNATIVE-FUELS)

ST77 10005 INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973-1975), VOLUME 1, COMMITTEE ON SCIENCE AND TECHNOLOGY (U.S. HOUSE)

(Washington, GPO Sponsored by ERDA and NSF, Prepared by ORNL, Oak Ridge National Lab., TN), 921 p., Rept. For Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., Jan 1976, GPO-64-734-Vol-1, W-7405-ENG-26, N77-13525  
 Avail:SOD HCS8.60

An updated assessment of the National Energy Resources and Technology is presented. The inventory listings encompass all energy-related research and development concerned with (1) energy sources, (2) electric power generation, transmission, distribution, and storage, (3) energy uses and conservation, (4) economic and legal aspects; and (5) health and environmental studies. Bibliographies with short description of the studies are organized in four volumes as prepared for the U.S. House of Representatives.

(ENERGY-OVERVIEW, BIBLIOGRAPHY)

ST77 10006 INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973-1975), VOLUME 5, COMMITTEE ON SCIENCE AND TECHNOLOGY (U.S. HOUSE)

(Washington, GPO Sponsored by ERDA and NSF, Prepared by ORNL, Oak Ridge National Lab., TN), 160 p., Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr. 2d Sess., Jan 1976, GPO-64-734, N77-14579  
Avail:SOD HCS2.30

The survey measures the research and development (R and D) efforts to expand the sources of energy as well as R and D aimed at controlling the impact of energy production and use on the environment. These inventory studies afford an overview of the R and D being performed in every aspect of energy exploration, production, distribution, use, and conservation.

(ENERGY-OVERVIEW, ECONOMICS, ENVIRONMENTAL-IMPACT)

ST77 10007 NASA OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY SUMMER WORKSHOP, VOLUME 4, POWER TECHNOLOGY PANEL, FINAL REPORT

(NASA, Langley), (Old Dominion Univ., Norfolk, VA), NASA-TM-X-73964, 195 p., Prepared Jointly With Old Dominion Univ., Norfolk, VA, Conducted at Madison College, Harrisonburg, VA, Aug 3-16, 1975, NSG-1186, N77-13913  
Avail:NTIS

Technology requirements in the areas of energy sources and conversion, power processing, distribution, conversion, and transmission, and energy storage are identified for space shuttle payloads. It is concluded that the power system technology currently available is adequate to accomplish all missions in the 1973 mission model, but that further development is needed to support space opportunities of the future as identified by users. Space experiments are proposed in the following areas power generation in space, advanced photovoltaic energy converters, solar and nuclear thermoelectric technology, nickel-cadmium batteries, flywheels (mechanical storage), satellite-to-ground transmission and reconversion systems, and regenerative fuel cells.

(ENERGY-OVERVIEW)

ST77 10008 NATIONAL PLAN FOR ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION: CREATING ENERGY CHOICES FOR THE FUTURE. VOLUME I. THE PLAN

(ERDA, Washington, DC), 125 p., 1976, ERDA-76-1, PCS\$5.50/MFS3.00

This is the first annual update of the initial report, ERDA-48, of June 1975 (EAPA, 1: 01621). ERDA's proposed National Plan has been expanded in scope and depth of coverage and the basic goals and strategy are refined, but remain essentially intact. The Plan summarizes ERDA's current views on the energy technologies the Nation will need to achieve longer-term energy independence. Specifically, the Plan addresses the paramount role of the private sector in the development and commercialization of new energy technologies; singles out conservation technologies for increased attention that are now ranked with several supply technologies as being of the highest priority for national action; requests a 30 percent increase in the 1976 budget for funding energy R and D; and directs Federal programs to assist industry in accelerating the market penetration of energy technologies with near-term potential. The chapters are: The National Energy Problem and the Nature of Its Solution; Fundamentals of the Plan; The Plan and the Federal Energy RD and D Program for FY 1977; Implementing the Plan: Interrelationships Among Energy RD and D Participants; Implementing the Plan: ERDA Planning System: Factors Influencing the Evolution of the Plan; and Future Evolution of the Plan. Two appendixes, Perspective on World Resources and Net Energy Analysis of Nuclear Power Production, follow. A glossary and a selected bibliography complete the report.

(ENERGY-OVERVIEW)

ST77 10009 PROCEEDINGS OF IEEE SOUTHEASTCON, REGION 3 CONFERENCE, 1976

Anon, (IEEE, SC Affil of Sect, New York, NY), Proc of IEEE Southeastcon, Reg 3 Conf, Clemson Univ, SC, Apr 5-7, 1976, Publ by IEEE, New York, NY, 390 p., Cat N76 CH1059-5 REG 3, 1975

Proceedings included 136 papers that were grouped into 31 sessions dealing with power technology, digital systems, computer applications, electromagnetic waves, semiconductor techniques and phenomena, solar energy and cells, digital signal processing, control theory, radar, solid-state applications, microelectronics, aerospace electronics & systems; microprocessor computer systems, biological pattern processing, laboratory instruction, laser inertial navigators, communication systems, computers in control, large scale systems, teaching microelectronics, devices applications, bioinstrumentation, computers in design/simulation.



communication signal processing, noise in semiconductor devices, and PSI (Personalized System of Instruction).

(ENERGY-OVERVIEW, POWER-TECHNOLOGY)

ST77 10010 WORLD RESOURCES - ENGINEERING SOLUTIONS

Anon, (ICE, London, England), Proc of the Jt Conf of the ASCE and the ICE, 3rd, Harrogate, England, Sept 30-Oct 3, 1975, Publ by ICE, London, England, 204 p., 1976

Proceedings include 10 papers that contribute to population environment; fossil fuel resources and energy conservation; nuclear and solar power; production of ores and manufacture and use of metallic resources; resources of manufactured and natural nonmetallic materials; water as a reusable resource; and timber as a replaceable resource.

(ENERGY-OVERVIEW, ENVIRONMENTAL-IMPACT)

ST77 10011 THE 94TH CONGRESS AND THE ENERGY RECORD

(Washington, GPO Prepared by Library of Congr.), 78 p., Committee on Interior and Insular Affairs, U.S. Senate, Library of Congress, Washington, DC, Rept. Pursuant to S. Res. 45 for Comm. on Interior and Insular Affairs, 94th Congr., 2d Sess., 1976, GPO-67-716, N76-31672  
 Avail:Comm. on Interior and Insular Affairs

Congressional measures to encourage the conservation of energy and the development of new energy sources are reviewed. Petroleum and its products, coal, natural gas, nuclear energy and solar energy are included.

(ENERGY-OVERVIEW, CONSERVATION)

ST77 10012 ENERGY IMPLICATIONS IN SOUTHWESTERN AGRICULTURE

Abernathy, G.H., Barnett, K.M., Gupta, Y.P., Wilson, D.B., Hazelton, T., Stevens, T.H., Keaton, M.L., Neberay, Y.I., Edington, B.D., Lansford, R.R., McCaslin, B.D., Titman, P.S., Rodriguez, V.L., Patrick, N.A., Smith, G.S., Kiesling, H.E., Staffeldt, E.E., Barkley, W., Ford, Q., Willem, R.A., La France, L.J., Stevens, W.C., (Sponsored by: New Mexico State University, Research Council, Las Cruces, NM), 4th Annual NMSU Conference on Energy, Feb 7-8, 1977

No Abstract Available

(ENERGY-OVERVIEW, UNITED STATES)

ST77 10013 THE ENERGY PROBLEM AND THE EARTH'S FUEL SITUATION

Bainbridge, G.R., (Newcastle-Upon-Tyne, University, Newcastle-Upon-Tyne, England), In Aspects of Energy Conversion, Proceedings of the Summer School, Oxford, England, July 14-25, 1975, Pergamon Press, Oxford, p. 3-25, 1976, Discussion, p. 26, 27, A77-11026 01-44, A77-11027

The energy problem is discussed primarily as it affects Britain, with attention given to oil dependence, the relation of fuel and living standards, the implications for the birth rate and the quality of life, and the increasing demand for limited world fossil fuels. Tables summarizing British fuel reserves coal, oil and gas and the North Sea oil reserves, are presented. New energy technologies are examined including nuclear fission, fusion, solar, geothermal, deep earth heat, tidal energy, wave energy, and wind energy.

(ENERGY-OVERVIEW, UNITED KINGDOM, FUEL-RESOURCES)

ST77 10014 SOURCEBOOK FOR ENERGY ASSESSMENT

Beller, M., (Brookhaven National Lab., Upton, NY), 211 p., 71 refs, Dec 1975, 46 tables, 25 figures, BNL-50483, Price code

An analytical approach is presented that is broadly applicable to the assessment of energy technologies and policies. Using the Reference Energy System approach, it permits the examination of the economic, environmental, and resource implications resulting from the substitution of one fuel or technology for another. Included as tools for such analyses are the necessary data and methodology, as well as a set of Reference Energy Systems covering the 1972-2020 period to serve as baselines for the perturbation analyses of interest.

(ENERGY-OVERVIEW, TECHNOLOGY-POLICY-ASSESSMENT)

ST77 10015 REFERENCE ENERGY SYSTEM METHODOLOGY

Beller, M., (Brookhaven National Lab., Upton, NY), 11 p., Apr 1976, CONF-760402-7, BNL-21079, PCS3.50/MFS3.00

The Reference Energy System (RES) is a network representation of all of the technical activities required to supply various forms of energy to end-use activities. Analytical techniques are described to examine all operations involving specific fuels including their extraction, refinement, conversion, transport, distribution, and utilization. Each of these

activities is represented by a link in the network for which efficiency, environmental impact, and cost coefficients may be specified. The network is quantified for a given year with the level of energy demands and the energy flows through the supply activities that are required to serve those demands. RESs were developed for the years 1980, 1985, 1990, 2000, and 2020. The RESs are used in an assessment to evaluate new technologies by the techniques of perturbation analysis. Inserting data on new technologies into an RES produces a Perturbed Energy System (PES). The Brookhaven Energy System Optimization Model (BESOM) includes the same input parameters and can be used for more extensive analyses where optimization is desired.

(ENERGY-OVERVIEW, FUELS-OPTIMIZATION, ENVIRONMENTAL-IMPACT)

#### ST77 10016 PROGRAM FOR REGIONAL ENERGY ANALYSIS, VOLUME I, FINAL REPORT

Benson, W.R., (Midwest Research Inst., Kansas City, MO), 141 p., ERDA-107-Vol-1, AT(49-1)-3755 MRI Proj. 4046-E, N76-33629  
 Avail:NTIS HC\$5.45

A program of action was designed for the participation of local, state, or regional organizations with crucial roles in energy policy and energy research and development. The regional energy analysis program provides a uniform procedure for analysis of the regional impacts and the consequences of policy decisions relative to research and development leading to new energy sources. It is also applicable to the analysis of the impacts of significant expansion of existing supply sources. Tasks that formed the basis for the program design were definition of regions, identification of data sources, inventory of models, public participation strategy, and development of candidate programs. As the regional energy analysis program evolved, elements of the program were selectively tested or validated using data from a new energy production technology. An oil shale plant and a solar thermal electric power plant were used in the tests because of the availability of data.

(ENERGY-OVERVIEW)

#### ST77 10017 ASPECTS OF ENERGY CONVERSION

Blair, I.M., ed., (Energy Technology, Support Unit, Harwell, Berks., England), Jones, B.D., (National Institute for Research in Nuclear Science, Chilton, Oxon, England), Van Horn, A.J., (Harvard University, Cambridge, MA), Pergamon Press, Oxford, England, 860 p., 1976, Proceedings of the summer school, Lincoln College, Oxford, England, July 14-25, 1975

The broad topics considered are the fundamentals of energy resources and consumption, fossil fuels, nuclear fuels, alternative energy sources (geothermal, solar, waste energy), transmission and storage of energy, environmental and socio-economic aspects of energy use, and energy analysis. Particular papers are on energy use in industry, energy use in agriculture, domestic energy use and conservation in buildings, and energy use in the coal, oil and gas industries. Also considered are possible energy developments in transportation, total energy systems, the effect of energy use on future industrial processes, energy and the developing countries, and radioactive waste management. Individual items are announced in this issue.

(ENERGY-OVERVIEW, ENVIRONMENTAL, SOCIO-ECONOMIC)

#### ST77 10018 ENERGY AND CLIMATE

Bolin, B., (Stockholm Univ., Sweden), 58 p., Nov 1975, N76-33819/3WE

A summary of knowledge of those mechanisms that determine the climate of the earth is given, and the possibility that man, directly or indirectly, may influence the climate is discussed. Topics dealt with include climatic changes since the last glaciation, some aspects of the general circulation of the atmosphere and its importance of the distribution of climatic zones on the earth, energy fluxes in the climatic system, climatic changes and their possible causes, and possible future climatic changes caused by an increasing energy production.

(ENERGY-OVERVIEW, ANTHROPOGENIC-IMPACT)

#### ST77 10019 PERSPECTIVE ON MATERIALS IN THE ENERGY PROGRAM

Claassen, R.S., (Sandia Labs., Albuquerque, NM), 34 p., 40 refs, 1976, CONF-760133-1, SAND-76-3155

This is an introductory paper for a series of presentations treating the general theme "Critical Materials Problems in Energy Production." Energy and materials are closely linked in many ways; e.g., production of materials, which requires their recovery and processing to manufacturing, consumes about 17 percent of all energy used in this country. To fully understand how materials affect our evolving energy program, one needs first to understand the interconnections with other aspects of the situation. Thus, in Section I, some historical perspective reveals what energy consumption has been thus far and what it is likely to be in the future. Section II provides the units and conversion factors most often used in energy discussions. The uses of energy and the forms that energy must take to be consumable are summarized in Section III. Financial aspects, particularly capitalization problems and fuel expenses, are covered in Section IV. The final section then provides a brief description of the materials problems to be discussed by the other authors in this series.

(ENERGY-OVERVIEW, ENERGY-CONVERSION)

ST77 10020 POWER SOURCES 5: RESEARCH AND DEVELOPMENT IN NON-MECHANICAL ELECTRICAL POWER SOURCES

Collins, D.H., ed., Proc of the Int Power Sources Symp, 9th, Brighton, England, Sept 24-26, 1974, Publ by Academic Press, Inc, New York, NY, 740 p., 1975

Forty-seven papers provide information on research and development, applications engineering, design studies, and user-experience of primary and secondary cells, solar cells, thermoelectric generators, and related subjects. Papers include: gas recombination of lead-acid batteries; battery charging at low temperatures; effects of metallurgical structure on hydrogen evolution on lead alloys; gassing rates of automotive batteries; zinc-bromine storage battery for electric vehicles; iron-air battery systems for traction purposes; high efficiency thermo-mechanical generators; performance characteristics of a long life pacemaker cell; and inorganic electrolyte lithium cells.

(ENERGY-OVERVIEWS)

ST77 10021 SYMPOSIUM ON ENERGY SOURCES FOR THE FUTURE, 1975

Duggan, J.L., ed., Cloutier, R.J., ed., (North Texas State Univ, Denton, TX), Symp on Energy Sources for the Future, Oak Ridge, TN, July 7-25, 1975, Publ by ERDA, Tech Inf Cent, Oak Ridge, TN, 303 p., 1975

Avail:NTIS Springfield, VA

The volume contains 17 papers dealing with energy problems and possible solutions. Topics covered include nuclear, solar, geothermal and MHD energy resources. Selected papers are indexed separately.

(ENERGY-OVERVIEW)

ST77 10022 ENVIRONMENTAL IMPLICATIONS OF FUTURE ENERGY ALTERNATIVES

Durie, R.W., Biswas, A.K., (Environment Canada, Ottawa, Ontario), 14 p., 1973, CONF-731033-7, MFS3.00, U.S. Sales Only

The environmental impact from growing prosperity is discussed with the idea of attitude change to energy consumption rates. Comparative evaluations are given for usage and environmental damage from fossil fuels (oil, natural gas, coal), hydroelectric dams, and nuclear energy. Eight full-page graphs, charts and tables are included to assess the pollution aspects of water, air, land and solid waste management for fossil fuels and radiation hazards from nuclear fuels. Socio-economic factors and health hazards are also covered.

(ENERGY-OVERVIEW)

ST77 10023 ENERGY FOR TOMORROW

Dutkiewicz, R.K., Bennett, K.F., (Univ of Cape Town, South Africa), 14 p., 4 refs, 1976, Int Conf on Air Pollut, Univ of Pretoria, South Africa, Apr 26-29, 1976, Sponsored by Dep van Gesondheid van South Africa, S. 121

Trends, in energy production and their effect on air pollution are reviewed. The unconventional energy forms are discussed. Developments in the cleaner utilization of coal are examined and it is felt that these developments will play a large part in pollution abatement.

(ENERGY-OVERVIEW, ENVIRONMENT, POLLUTION)

ST77 10024 STRUCTURE OF A SIMULATION MODEL FOR ENERGY-RELATED REGIONAL ASSESSMENT

Fraley, D.W., Swift, W.H., (Battelle Pacific Northwest Labs., Richland, WA), 23 p., 1976, CONF-760435-4, BNWL-SA-5677, PC A02/MF A01

The structure of a dynamic simulation model designed to analyze the effects of potential future energy policies and actions as a multistate, regional level is described. The simulation structure includes the interacting effects of energy development, energy- and macro-economics, and demography on land use, water resources, air quality, ecosystems, and society.

(ENERGY-OVERVIEW, MACRO-ECONOMICS, ENVIRONMENT)

ST77 10025 ENERGY AND ENVIRONMENT POST-2000

Gibrat, R., Sciences et Techniques, p. 5-14, Nov 1976, A77-14560, In French

General environment and energy resources and disposal problems extrapolated to the next century are surveyed, with focus on hydrogen/electricity economy, global climatology and CO2 disposal, long-term climatological changes and predictions of interglacial era duration, and applications of topology and catastrophe theory to environment and climatology problems. Projections on population level, energy needs and resources, and a population of 12 billion using 60 TW energy are considered for the year 2000 and beyond. The basics of Thom (1970) Catastrophe Theory and Possible Applications are outlined. Disposal of waste heat and excess CO2 generated by industry in the waters of the Antarctic (Weddell Sea) is weighed, favorably, in the light of oceanographic data.

(ENERGY-OVERVIEW, CLIMATOLOGY)

ST77 10026 AN ADVANCED ENERGY CONSERVATION TECHNOLOGY PROGRAM; PROCEEDINGS OF THE INTERSOCIETY WORKSHOP CONFERENCE, AIRLIE HOUSE, VA, MARCH 24-26, 1976

Gray, J., ed., (American Institute of Aeronautics and Astronautics, New York, NY), 96 p., 1976, Conference sponsored by AIAA, AICHE, ASHRAE, ASME, and ERDA, New York, American Institute of Aeronautics and Astronautics, Inc., A77-12928

The conference was assembled to consider the processes by which advanced energy conservation engineering knowledge and methods are introduced into practical end-product manufacture and use, and to examine the possibilities for accelerating these processes. Ten major technologies were identified which affect energy conservation and which utilize advanced engineering methods waste heat recovery, instruments and controls, energy conversion (including combustion and heat transfer), energy transmission and storage, materials (including recycling), analytical methods and modeling, manufacturing processes, basic component design, system integration, and alternative energy sources. The areas of application for some or all of these techniques were grouped into five general categories transportation, heating and cooling, electric power generation, end-product manufacture, and process industries.

(ENERGY-OVERVIEW)

ST77 10027 ENERGY STRATEGIES

Hafele, W., Sassin, W., (Int Inst for Appl Syst Anal, Laxenburg, Austria), Energy, Oxford, V 1:147-163, N2, 18 refs, June 1976

The amount of fossil energy reserves and resources suggests a transition to energy supply system that is based on a quasi-infinite fuel supply. Several options exist for this transition such as the nuclear breeder or solar power. Strategies for transitions have to meet a certain demand for energy. A simple but global scenario is given for such energy demand with emphasis on low demand in conjunction with fossil fuels. Consideration is given to the constraints of such fossil energy production and emphasis is put on the CO<sub>2</sub> problem. This allows a rough understanding of the time scale of such transitions. In view of the timing of the transition the various options for quasi-infinite supplies of energy are considered and priorities of a number of physics tasks are conceived.

(ENERGY-OVERVIEW, TRANSITION-STRATEGIES, ENVIRONMENT)

ST77 10028 AN OVERVIEW OF ALTERNATE ENERGY RESOURCES FOR POWER GENERATION - 1975-2000

Hauser, L.G., (Westinghouse Electric Corp., Pittsburgh, PA), In Symposium on Alternate Fuel Resources, Santa Maria, CA, Mar 25-27, 1976, Proceedings, Western Periodicals Co., North Hollywood, CA, p. 15-22, 1976, American Institute of Aeronautics and Astronautics, Inc., Vandenberg, CA, A76-47289

The paper discusses the probable future trends in electric power generation in terms of energy source and type of generation for the period 1975-2000 in the USA. Twelve new energy system alternatives are shown to be suitable for successful economic feasibility. Selections should be made among these 12 alternatives for higher priority development efforts. Five alternatives would be most beneficial for the last quarter of this century breeder reactor with steam turbines, combined cycle (combustion/steam turbine) with a coal-derived fuel, steam turbine fired by municipal wastes, wind turbine generators, and batteries.

(ELECTRICITY, ECONOMICS)

ST77 10029 SYMPOSIUM ON ALTERNATE FUEL RESOURCES, SANTA MARIA, CALIFORNIA, MARCH 25-27, 1976, PROCEEDINGS

Hendel, F.J., ed., (California Polytechnic State University, San Luis Obispo, CA), Monograph On Alternate Fuel Resources, Western Periodicals Co., North Hollywood, CA, V 20:469, 1976, Symposium Sponsored by American Institute of Aeronautics and Astronautics, Inc., Vandenberg, CA, A76-47287, PCS45.00

The present collection of papers is concerned with advances in and projects for alternatives to conventional fuels and energy sources in order to meet the USA future energy requirements. Major areas discussed include overall aspects of alternate fuel resources, development of synthetic fuels, gas turbine and diesel oil alternates, oil shale retorting, and alternates to gasoline in automotive transportation. Other topics concern gas and coal utilization, pollution consideration in alternate fuels, and fuel and energy from solid waste and biomass.

(ENERGY-OVERVIEW)

ST77 10030 ENERGY CONVERSION AND UTILIZATION - BOOK

Krenz, J.H., (Colorado, University, Boulder, CO), 367 p., 1976, Allyn and Bacon, Inc., Boston, MA, A77-14957, PCS17.95

The energy crisis is considered along with aspects of energy consumption, the fossil fuel reserves, the solar energy balance of the earth, problems of carbon dioxide generation, atmospheric pollution, thermodynamic limitations, and questions related to the generation of electrical energy from fossil fuels. Topics related to the utilization of nuclear energy are discussed, taking into account the fission chain reaction, thermal neutron reactors, fast neutron

breeder reactors, fission wastes and other limitations, requirements for a thermonuclear fusion reaction, magnetically confined plasma fusion devices, and laser induced fusion. Attention is also given to the potential of solar energy, low and high temperature applications of solar energy, photovoltaic solar cells, photosynthesis, hydropower, tidal power, power from ocean temperature gradients, wind power, geothermal power, and questions related to energy usage and the U.S. economy.

(ENERGY-OVERVIEW, ENVIRONMENT)

#### ST77 10031 ENERGY RESEARCH IN THE UNITED KINGDOM

Marshall, W., (Department of Energy, London, United Kingdom Atomic Energy Authority, Harwell, Berks., England), Atom, p. 302-313, Dec 1976, A77-15812

An overview is presented of research and development in the field of energy in the United Kingdom. Attention is given to the contribution of coal, oil and natural gas technologies and to that of nuclear energy. The overall importance of alternative energy sources (fusion, geothermal, solar, tidal, wave, wind, oil shale, and waste) is examined along with the importance of different energy conversion and distribution technologies such as coal conversion, electricity supply, and gas supply. The overall importance of energy utilization technologies (fuel utilization and energy conservation).

(ENERGY-OVERVIEW, UTILIZATION, ALTERNATIVES)

#### ST77 10032 UMR-MEC CONFERENCE ON ENERGY, 2ND ANNUAL, PROCEEDINGS, 1975

Morgan, J.D., ed., (Univ of Missouri, Rolla, MO), UMR-MEC Conf on Energy, 2nd Annu. Proc. Pap, Univ of Missouri, Rolla, Oct 7-9, 1975, Publ by West Period Co, North Hollywood, CA, 433 p., 1976

The volume contains 44 papers dealing with energy sources, generation, conservation and utilization. The papers are grouped under following titles: Energy management; Wind and solar energy; Chemical energy conversion; Economics of energy; Energy systems; and Energy environment.

(ENERGY-OVERVIEWS, GENERATION, UTILIZATION)

#### ST77 10033 THE AVAILABILITY OF FUELS FOR POWER PLANTS

Olds, F.C., Power Engineering, V 80:42-49, Sept 1976, A77-11316

Questions of fuel availability are examined, taking into account the existing coal reserves in the world and in the U.S., the feasibility of deep open pit mining, questions concerning the possibility of maintaining a high energy growth rate, and the plight of the nonoil developing countries. Attention is also given to a global energy projection, the global energy use rate, and alternative fuels.

(ENERGY-OVERVIEW, UTILIZATION)

#### ST77 10034 ENERGY. VOLUME 3 - NUCLEAR ENERGY AND ENERGY POLICIES - BOOK

Penner, S.S., ed., (California, University, La Jolla, CA), Addison-Wesley Publishing Co., Inc., Reading, MA, 749 p., 1976, A76-43448, PC\$28.50

Nuclear fission energy is considered with emphasis on the development of pressurized water reactors, boiling water reactors and high temperature gas cooled reactors, and breeder reactors are examined in detail. Controlled fusion is discussed with attention paid to types of magnetic confinement, and the stability and transport properties of confined plasmas. The environmental aspects of nuclear power applications are considered, with discussions of accidents involving nuclear fission reactors, radiation protection standards, nuclear waste disposal and estimates of environmental and safety aspects of fusion power. A section is devoted to energy policies, examining the global impact of energy use, energy conservation and solar heating and cooling.

(ENERGY-OVERVIEW, ALTERNATIVES)

#### ST77 10035 COMPREHENSIVE STANDARDS: THE POWER GENERATION CASE

Pigford, T.H., Keaton, M.J., Mann, B.J., Sessler, G.L., (Teknekron, Inc., Berkeley, CA), 360 p., Mar 1975, Teknekron/EEED-104, Teknekron/EEED-105, PB-259 876/LWE

This report presents an illustrative data base of material quantities and environmental effluents in the fuel cycles for alternative technologies of thermally generated power. The entire fuel cycle for each of ten alternative technologies is outlined for a representative power plant generating 1000 Mw of electrical power. The required utilization of material resources and the fuel-cycle material quantities are indicated on a flow sheet for each technology. The technologies considered are: Light-water nuclear reactor; Coal; Residual fuel oil; Natural gas; High-sulfur coal, with coal gasification and sulfur removal; High-sulfur coal, with SO<sub>2</sub> recovery by wet-limestone scrubbing; Geothermal steam; Breeder fission reactor; Solar energy; Thermonuclear fusion.

(ENERGY-OVERVIEW, ENVIRONMENT, ALTERNATIVES)

Potter, R.F., (Office of Naval Research, London, England), 17 p., Third Conf. Held in Bucharest, Romania, Sept 9-12, 1975, AD-A026962 ONRL-C-14-76, N77-15511  
 Avail:NTIS

This report covers portions of most of the plenary sessions including the opening session of the conference, Physics and Energy; Energy Strategies; Maturity of Nuclear Energy; Use of Solar Energy; New Goals and Challenges; Photochemistry; Thermonuclear Research; Energy, Dissipation and Structure; Transport and Storage of Energy. Other sessions covered are on Solar Energy Use, Transport and Storage of Energy and Energy Research Strategies.

(ENERGY-OVERVIEW)

## ST77 10037 ENERGY RESEARCH FOR PHYSICISTS

Reynolds, G.T., (Princeton University, Princeton, NJ), Physics Today, V 29:34-41, Dec 1976, A77-15350

Challenging problems for physicists probing into exploitation of novel energy resources are reviewed and outlined. Attention is centered on applications of fluid dynamics in harnessing of wind power, solar energy, solar power stored in ocean temperature differentials, and geothermal energy. Advanced design of solar reflectors and concentrators, collection of wind power over a broad area with convection through a vertical stack, difficulties in exploitation of ocean depths as a heat reservoir, and types of geothermal reservoirs are discussed. Stimulating fluid production from presently unproductive hydrothermal reservoirs, working with dry geothermal reservoirs, qualitative advances in drilling techniques, improved water-to-steam conversion, handling of mineralized geothermal fluids, and improved thermodynamic power cycles are considered as examples of intriguing problems for physicists working on tapping geothermal energy.

(ENERGY-OVERVIEW, ALTERNATIVE-RESOURCES)

## ST77 10038 ENERGY MATHEMATICS AND MODELS; PROCEEDINGS OF THE CONFERENCE, ALTA, UTAH, JULY 7-11, 1975

Roberts, F.S., ed., (Rutgers University, New Brunswick, NJ), 301 p., 1976, Conference sponsored by the Society for Industrial and Applied Mathematics and National Science Foundation Philadelphia, PA, Society for Industrial and Applied Mathematics, A77-11233, PCS16.00

The present papers by mathematicians and energy researchers have the objective to delineate the role of mathematics in energy research and to describe the circumstances under which application of mathematical analysis to the energy problem could be meaningful and useful. The individual papers demonstrate the mathematical tools relevant to the energy problem and examine the amenability of significant problems to mathematical analysis.

(ENERGY-OVERVIEW, TECHNOLOGY-FORECASTING)

## ST77 10039 ENERGY AND THE ENVIRONMENT, 3RD NATIONAL CONFERENCE, PROCEEDINGS, 1975

Rolinski, E.J., ed., Buonicore, A.J., ed., Earley, D.E., ed., Theodore, L., ed., Rolsten, R.F., ed., Servais, R.A., ed., Energy and the Environ, 3rd Natl Conf, Proc, Pap, Huaston Woods State Park, Ohio, Sept 29-Oct 1, 1975, Publ by AIChE, Dayton, and Ohio Valley Sect, New York, NY, 404 p., 1975

Fifty-six papers, four abstracts, and a brief talk on man and technology are presented. The topics discussed are: Socioeconomic impacts of Western energy development, fuel energy estimates, EPA role in energy R&D, capital projects, plant siting, energy conservation, waste to fuel, shale and coal oils, MHD generators, combined cycle power plants, solar thermal energy storage, ferrous iron catalysis, metal-aromatic polymers, solar heating of cooling, refuse to energy, thermal discharges and living systems, nuclear power, oil-from-waste processes, district heating with refuse, sensors in urban air monitoring, emission test procedures, source tests, opacity measurements, SO<sub>2</sub> removal, surface condensers, cyclones, bag filters, halohydrocarbon toxicity, single stack feasibility, ignition systems, baghouse performance, fugitive dust control, and industrial odor problems.

(ENERGY-OVERVIEW, ENVIRONMENT, UNITED-STATES)

## ST77 10040 NUCLEAR POWER - COMPARED TO WHAT - ENERGY ALTERNATIVES FOR ELECTRIC POWER GENERATION

Rose, D.J., (MIT, Cambridge, MA), Leskovjan, L.L., (Florida Power and Light Co., Miami, FL), Walsh, P.W., NSF ST-40016000, American Scientist, V 64:291-299, May-June 1976, A77-12234

The paper is concerned with long-term decisions which will affect electric power generation towards the end of the century. Petroleum and natural gas being scarce at that time, the real choices will be among nuclear fission (with breeder reactors in prospect), controlled nuclear fusion, solar power, and coal. These major alternatives are comparatively assessed from economic, environmental and societal points of view. An analysis of U.S. available fuel resources leads to the conclusion that the only near-term alternatives are nuclear fission and coal power. Health hazards of nuclear fission power including those from mining, radio activity, reactor accidents and nuclear waste disposal are discussed, as well as health effects of coal-

generated power arising from mining, direct burning, and the conversion of coal through gasification and liquefaction. Particular attention is given to the environmental impact of coal burning products, such as sulfur oxides, nitrogen oxides, particulates, and trace metals. For the long term, controlled fusion and solar power are briefly discussed. It is concluded that the nuclear fission appears to be the most acceptable technology from all the discussed points of view.

(ENERGY-OVERVIEW, TECHNOLOGY-FORECASTING)

ST77 10041 ENERGY PROBLEMS AND POTENTIAL SOLUTIONS

Schmid, L.C., (Battelle Pacific Northwest Labs., Richland, WA), 13 p., BNWL-SA-5622, E(45-1)-1830, N76-31689  
 Avail:NTIS HC53.50

The past and future trends in energy use show a greater growth rate for oil and gas relative to other resources, and reserves of these resources are not being found as rapidly as they are being removed from the ground, resulting in greater dependence of imported Eastern oil. This has resulted in a trade imbalance. These factors are resulting in some current shortages of energy, especially electrical power and natural gas; increasing energy costs; a growing dependence on foreign supplies of fuel; and increased consideration of the social and environmental aspects of energy production, as well as technical and economic ones. In the short and intermediate term, logical solutions based on the energy scenario are to reduce energy demand through conservation; to move away from using scarce resources such as oil and gas which now provide approximately 78% of U.S. energy; to move toward the use of more abundant resources such as coal and uranium; and to develop domestic supplies of oil and gas. In the longer term, renewable sources such as solar, fusion, and geothermal need to be developed.

(ENERGY-OVERVIEW, UNITED-STATES, ENVIRONMENT)

ST77 10042 IMPACTS OF ALTERNATIVE ELECTRICITY SUPPLY SYSTEMS FOR CALIFORNIA AND ANALYSIS OF SUPPLY-DEMAND OF ELECTRICITY FOR THE TWELVE WESTERN STATES 1973 TO 1990

Siri, W.E., Sathaye, J.A., Kunin, L., Ruderman, H., Sextro, R., Chan, P., Horovitz, M., (Energy and Environment Division, Lawrence Berkeley Laboratory, University of California, Berkeley, CA), Higgins, G.H., (Energy and Resource Program, Lawrence Livermore Laboratory, University of California, Livermore, CA), 224 p., Apr 26, 1976

While recognizing that a shift in major energy sources for the future can, in principle, affect in some degree every segment of society, the economy, and the environment, this study necessarily confines itself primarily to an analysis of direct costs and pollutants associated with alternative means for supplying electricity to California, and certain direct consequences of phasing out nuclear energy. The data, however, may also serve as a basis for judging implications for some of the indirect economic impacts and environmental effects.

(ENERGY-OVERVIEW, ENVIRONMENT)

ST77 10043 DEVELOPMENT TRENDS IN ENERGY SUPPLY

Speiser, A.P., (Brown Boveri & Co, Baden, Switzerland), Elektrotech Maschinenbau, V 93:295-301, N7, July 1976, In German

The five main energy sources are discussed, namely, petroleum, natural gas, coal, water, and nuclear energy. Alternative energy sources for the future are considered, such as wind, geothermal and solar energy. It is pointed out that solutions to energy problems should not be sought solely in scientific and engineering R & D. Economic, political and psychological aspects are, at least, as important.

(ENERGY-OVERVIEW, ALTERNATIVES, SOCIO-ECONOMICS)

ST77 10044 IEA ENERGY SIMULATION MODEL - A FRAMEWORK FOR LONG-RANGE U.S. ENERGY ANALYSIS

Whittle, C.E., Reister, D.B., Silver, E.G., Weinhold, J.F., Ahmed, S.B., Davitian, H.E., MacPherson, H.G., Perry, A.M., (Institute for Energy Analysis, Oak Ridge, TN), 160 p., ERDA-14-01-0001-1699, ORAU-125 IEA-75-1, N77-14594  
 Avail:NTIS

A model was developed for simulating plausible U.S. energy supplies and demands for the last part of this century and the early part of the 21st century. This model was intended to give policy makers a means of comparing various possible futures for energy supplies and demands and for determining which combinations allow a feasible match between the projected demands and the available domestic supplies. Demand functions were generated for each of the energy carriers (electricity, liquids, gases, and solids) by examining the industrial, residential and commercial, and transportation demand sectors in terms of their component activities. Supply functions have been generated independently for each of the energy carriers based on the best available data and estimates for the fossil fuels, uranium, hydroelectricity, geothermal heat, and solar energy and on present knowledge and projections about extraction and conversion technology.

(ENERGY-OVERVIEW, ECONOMICS, POLICIES)

ST77 11000 ENERGY - THE U.S. AT THE CROSSROADS

Environmental Science and Technology, V 10:854-859, Sept 1976, A76-43464

Energy policy is discussed in relation to the development of renewable energy sources. Emphasis is on solar energy technology, with discussions also of ocean thermal, tide and wind power. Economic factors associated with the development of renewable sources are examined.

(SOLAR-OVERVIEW, ENERGY-POLICY)

ST77 11001 INTERNATIONAL SOLAR ENERGY CONGRESS AND EXPOSITION, EXTENDED ABSTRACTS: SOLAR USE NOW - A RESOURCE FOR PEOPLE

Anon, (Int Sol Energy Soc, Smithsonian Rad Biol Lab, Rockville, MD), Int Sol Energy Congr and Expo, Extended Abstr, Univ of California, Los Angeles, July 28-Aug 1, 1975, Publ by ISES, Smithsonian Rad Biol Lab, Rockville, MD, 540 p., 1975

Proceedings of the congress include 270 papers presented in the extended abstract form. The following topics were discussed at the conference: economic and social aspects; developing countries; solar radiation; photovoltaic, photochemical, photobiological processes; solar furnaces; materials, flat plate collectors, energy storage; solar heating and cooling of buildings; drying and distillation; focusing collectors; and solar thermal power.

(SOLAR-OVERVIEW, SOCIO-ECONOMIC)

ST77 11002 LARGE SCALE SOLAR ENERGY TEST FACILITIES

Connell, H.L., ed., (Physical Science Laboratory, New Mexico State University), 477 p., Proceedings of the International Seminar on Large Scale Solar Energy Test Facilities, Las Cruces, NM, Nov 18-19, 1974, (NSF Grant AER 75-06866)

Avail: Prepared for the NSF, Research Applied to National Needs Program

The Seminar on Large Scale Solar Test Facilities, held at the Physical Science Laboratory on November 18-19, 1974, was sponsored by the National Science Foundation and brought together for the first time experts from all the world's existing large scale solar test facilities, U.S. industry, government and academic institutions, to define the requirements and design criteria for a future 5 MWth solar test facility to be built in the United States. The U.S. Army White Sands Missile Range co-hosted the seminar with New Mexico State University while the technical program and arrangements for all the speakers was coordinated by Georgia Institute of Technology. Grateful acknowledgement is made to these organizations for their support.

(SOLAR-OVERVIEW, INTERNATIONAL-SEMINAR)

ST77 11003 SOLAR ENERGY ENVIRONMENTAL AND RESOURCE ASSESSMENT PROGRAM - SUMMARY REPORT

(ERDA, Division of Solar Energy, Washington, DC), 53 p., Oct 1976, ERDA 76-138

Avail: NTIS PC54.50/MF\$3.00

This report describes the Environmental and Resource Assessment Program (ERA Program) which is an element of the National Solar Energy Program of the Energy Research and Development Administration. The purpose of this report is to present the activities and plans of the ERA program to the public, research and consulting organizations, state and local governments, other Federal agencies and thus improve communications. This report discusses the goals, mission, and organization of the ERA Program. The four ERA program areas are: (1) Environmental Assessment, (2) Technology Assessment, (3) Resource Assessment, and (4) Material Assessment. This report defines the scope of activities within each of the mentioned program areas. Project summaries or abstracts for all projects started in FY 1976 are presented. The FY 1976 project summaries are followed by a listing of planned activities for FY 1977.

(SOLAR-OVERVIEWS, UNITED-STATES)

ST77 11004 NON-CONVENTIONAL ENERGY TRENDS TO SUPPLEMENT OUR PETROLEUM RESERVES

Abdel-Aal, H.K., (Univ of Pet & Miner, Dhahran, Saudi Arabia), Energy Commun, V 2:535-558, N6, 22 refs, 1976

Based on the assumption that 1% of the land surface area is covered with solar collectors and the efficiency of solar conversion will not be 10% the global solar energy available for mankind is computed and its equivalent in barrels of oil is given for different geographical locations in the world. Under these conditions, a total of 123 thousand/million bbl could be collected annually on a global basis. Paper presents an engineering analysis of the prospects of utilizing solar energy as a potential source of providing heat throughout many industrial applications.

(SOLAR-OVERVIEW)



ST77 11005 PROSPECTS FOR SOLAR ENERGY UTILIZATION IN IRAN - PHOTOTHERMAL METHODS

Ali Mansoori, G., (Univ of Illinois, Chicago Circle, IL), Iran J Sci Technol, V 5:55-73, N2, 49 refs, 1976

The state of the art of the photothermal methods of solar energy utilization is reviewed and it is shown that many of these techniques are applicable in Iran due to both the favorable climatic conditions and the technological developments of the country.

(SOLAR-OVERVIEW)

ST77 11006 AN ENERGY CENTER IN SRI LANKA - UNITED NATIONS RURAL ENERGY DEVELOPMENT PROGRAM

Allison, H.J., Southerland, S.R., Gordon, C.E., (Oklahoma State University, Stillwater, OK), In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, New York, American Institute of Chemical Engineers, V 1:58-63, 1976, Research Sponsored by the United Nations Environment Program, A77-12662 02-44, A77-12669

In connection with the United Nations Environment Program (UNEP) effort to install rural energy centers in developing nations throughout the world, a model energy center is designed and installed in Sri Lanka (formerly Ceylon). The system will derive its input from a mix of solar, wind, and biogas energy, and produce electricity at power levels up to 30 to 50 kilowatts. Windmills will be used to generate electricity and pump water. A solar energy system is also to be employed. The electrical components of the solar and wind energy system will be connected to a storage system to insure an uninterrupted supply of energy. The solar energy component of the system consists of a moderate temperature solar collector which drives a Rankine cycle engine that produces direct current for charging a battery bank.

(SOLAR-OVERVIEW)

ST77 11007 INTERNATIONAL SYMPOSIUM ON SOLAR ENERGY, WASHINGTON, DC, MAY 5-7, 1976, PROCEEDINGS

Berkowitz, J.B., ed., (Arthur D. Little, Inc., Cambridge, MA), Lesk, I.A., (Motorola, Inc., Phoenix, AZ), 369 p., 1976, Symposium Sponsored by the Electrochemical Society Princeton, NJ, Electrochemical Society, Inc., A76-47051, PCS10.00

The papers collected deal principally with advances in technology and materials for conversion of solar energy into electrical energy with the aid of solar cells, with some work relating to technology for photothermal conversion and photogalvanic and photochemical cells. Some of the topics covered include chemical vapor deposition of molybdenum and tungsten films of high infrared reflectance, analysis of current-voltage and power characteristics of photogalvanic cells, thin film GaAlAs-GaAs solar cells by peeled film technology a comparison of GaAs and Si hybrid solar power systems, purification of metallurgical-grade silicon to solar grade, use of solar cells in a compound parabolic collector, and accelerated life performance characteristics of thin film Cu<sub>2</sub>S-CdS solar cells. Individual items are announced in this issue.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

ST77 11008 THE UTILIZATION OF SOLAR ENERGY AFTER EXHAUSTION OF FOSSIL AND MINERAL ENERGY SOURCES

Bossel, U., (Aerodynamische Versuchsanstalt, Goettingen, West Germany), Deutsche Gesellschaft Fuer Sonnenenergie, Graefelfing, West Germany, p. 35-60, 1976, In Solar Heating; Meeting, 1st, Goettingen, West Germany, Feb 23-24, 1976, reports, A76-45301 23-44, A76-45303. In German

The reasons for a utilization of solar energy are examined in connection with the limitations of fossil fuel resources and certain undesirable environmental effects related to their use. The characteristics of solar energy and its availability are considered along with suitable approaches for utilizing this energy. Attention is given to the direct and indirect utilization of solar heat, the employment of solar cells, problems of energy storage, and bioenergetic approaches. Economical and political considerations related to a utilization of solar energy are also discussed.

(SOLAR-OVERVIEW, ALTERNATIVES)

ST77 11009 SOLAR ENERGY - CONVERSION TECHNOLOGY ASSESSMENT

Brinkworth, B.J., (University College, Cardiff, Wales), In Aspects of Energy Conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975, Pergamon Press, Oxford, England, p. 431-447, 1976, Discussion p. 447, 448, A77-11026 01-44, A77-11037

The paper reviews the possibilities of the direct use of solar energy. Attention is given to solar energy fluxes, and the design and construction of solar collector. Solar space heating systems are considered together with solar thermal power plants (thermodynamic conversion) and conversion - thermionic, thermoelectric, and photovoltaic to electricity. Photochemical and photobiological energy conversion systems are also considered.

(SOLAR-OVERVIEW, WORKSHOP)

11015  
ST77 11010 SOLAR TOTAL ENERGY PROGRAM SEMI-ANNUAL REPORT, APRIL 1975-SEPTEMBER 1975

Champion, R.L., Edenburn, M.W., (Sandia Labs., Albuquerque, NM), 99 p., Apr 1976, SAND-76-0078, PC\$5.00/MF\$3.00

This report describes the activities of the Sandia Laboratories Solar Total Energy Program during the 6-month period, April 1975 through September 1975. Included are highlights of the period, descriptions of the system and its components, including recent modifications, and the results of systems analyses and component testing.

(SOLAR-OVERVIEW, SANDIA-LABS)

ST77 11011 NEW POTENTIALITIES FOR INTERNATIONAL CO-OPERATION IN THE FIELD OF SOLAR ENERGY AND ITS APPLICATIONS

Chatel, B.H., (Office for Science and Technology, United Nations, NY), Solar Energy, Pergamon Press, V 18:69-71, 1976

Solar energy has to be evaluated as an additional source which can complement the traditional sources of energy. From this point of view, a number of applications become economically feasible: (a) Heating, (b) Cooling, and (c) Electric power generation. In this perspective, UNESCO in 1970 launched anew its solar activities, on a modest basis, in education, in research, by disseminating information, and by providing technical assistance.

(SOLAR-OVERVIEW)

ST77 11012 SOLAR ENERGY RESEARCH AND UTILIZATION

Cherry, W.R., (ERDA, Washington, DC), Symp on Energy Sources for the Future, Oak Ridge, TN, July 7-25, 1975, Publ by ERDA, Tech Inf Cent, Oak Ridge, TN, p. 47-65, 24 refs, 1975, CONF-750733

Avail:NTIS Springfield, VA

The paper describes what role solar energy will play in the heating and cooling of buildings, the production of renewable gaseous, liquid and solid fuels, and the production of electric power over the next 45 years. Potential impacts on the various energy markets and estimated costs of such systems are discussed along with illustrations of some of the processes to accomplish the goals.

(SOLAR-OVERVIEW, CONFERENCE)

ST77 11013 THE POTENTIAL OF INDIGENOUS ENERGY RESOURCES FOR REMOTE MILITARY BASES - INTERIM REPORT

Connors, T.T., Morrison, P.F., Mow, C.C., Salter, R.G., (Rand Corp., Santa Monica, CA), 141 p., Document, AD-A022829 R-1798-ARPA, DAHC15-73-C-0181 ARPA Order 189, N76-33679

Avail:NTIS

An examination of the potential of solar radiation, wind, and ocean waves to provide thermal and electrical power to standard remote military bases. Sufficient energy is shown to be available in the North Atlantic, Indian, and Pacific Oceans, and the Caribbean to satisfy average remote base power requirements. A survey of indigenous energy technologies indicates that considerable research is needed to bring wave power recovery up to the level of solar and wind systems. An analytic computer model is used to show that indigenous energy systems are extremely costly, in part because of storage requirements, and that a mix of indigenous and conventional (petroleum) systems would be for less so. Since even a combined system is shown to exceed the cost of a pure conventional power supply, use of indigenous energy is justifiable only as a means of reducing the dependence of remote bases on petroleum fuels.

(SOLAR-OVERVIEW, CONVERSION)

ST77 11014 DESCRIPTION OF THE SOLAR ENERGY R AND D PROGRAMS IN MANY NATIONS. FINAL REPORT

de Winter, F., de Winter, J.W., (Atlas Corp., Santa Clara, CA), 298 p., Feb 1976, SAN/1122-76/1

The present report includes descriptions of the Solar Energy R and D Programs of 32 countries, of the Organization of American States, of UNESCO, and of a number of private organizations. The descriptions were solicited from the most reliable representatives known for the individual countries, and were received between late July 1975 and February 1976.

(SOLAR-OVERVIEW, INTERNATIONAL)

ST77 11015 PROCEEDINGS OF THE SOLAR ENERGY DEVELOPMENT HEARINGS CONDUCTED BY THE STATE OF ILLINOIS, APRIL 29, 30, 1975

Dunwoody, J.E., Casella, A., (Illinois State Dept. of Business and Economic Development, Springfield, IL), NSF/IDOE-75-02, 175 p., Nov 1975, PB-260 608/SWE

This document is a transcript of two days of public hearings on the Illinois Solar Energy Development Program. In addition to the 19 people who presented oral testimony at the hearings, an additional 27 people submitted extensive written comments. Viewpoints from major groups of

people currently interested in solar energy development in Illinois are reflected in these comments.

(SOLAR-OVERVIEW)

ST77 11016 PRELIMINARY ASSESSMENT OF SOLAR ENERGY TECHNOLOGY

Garg, P., (Duke Univ, Durham, NC), ASME Pap, 9 p., N76-WA/TS-1, 30 refs, Dec 5, 1976, for Meet

This paper describes the assessment of solar energy technology undertaken by an interdisciplinary team of students over a one-semester period. The methodology evolved by the group consists of problem definitions, a description of the state of technology, technological forecast, areas of impact, action-options, and recommendations. In addition, the paper discusses the solar energy component of the national energy plan, with a view to describe the program design envisioned by ERDA in this area.

(SOLAR-OVERVIEW, SOCIO-ECONOMIC)

ST77-11017 THE OPTIONS FOR USING THE SUN

Goodenough, J.B., (Oxford University, Oxford, England), Technology Review, V 79:63-71, Oct-Nov 1976, A77-10318

Several seriously proposed schemes for solar-energy utilization are discussed. The exploitation of the temperature difference between seawater at the ocean surface and at depths of a thousand meters and the conversion of municipal waste into fuel gas are cited as two illustrative cases of solar-energy utilization. Operational principles and components of solar-heat collectors are described, refrigeration systems powered directly by solar energy are considered, and ways to concentrate sunlight are reviewed. Alternatives for producing electric power from solar energy are summarized, including the use of windmills or hydropower to turn electric generators, direct conversion of solar energy to electric power by means of semiconductors, and indirect conversion by driving conventional turbine equipment with solar-derived heat. The conversion of solar energy into chemical energy is examined in terms of pyrolysis, electrolysis, photolysis, and photoelectrolysis of water. The problem of solar-energy storage is noted.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

ST77 11018 ENERGY - A RADICAL REDIRECTION

Gravel, M., (U.S. Senate, Washington, DC), Journal of Energy and Development, V 1:191-200, Spring 1976, A77-11275

Suitable approaches for a National energy policy are discussed, taking into account the goal of energy self-sufficiency for the U.S.. Current commitments in regard to energy policy are critically examined. It is concluded that the preferential treatment of the breeder reactor in the allocation of funds at the expense of solar energy options cannot be justified. The proposal is made to place greater emphasis on the development of approaches for the utilization of solar energy. Attention is given to solar heating and cooling of buildings, wind energy, and bioconversion to fuels. Difficulties concerning a use of solar cells are related to their high price. It is recommended to provide government support in assuring a market which would make a lowering of the production costs possible.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY, ECONOMICS, UNITED-STATES)

ST77 11019 SOLAR ELECTRIC POWER GENERATION (CITATIONS FROM THE ENGINEERING INDEX DATA BASE)

Hundemann, A.S., (NTIS, Springfield, VA), 197 p., Oct 1976, NTIS/PS-76/0797/1WE, PCS25.00/MFS25.00

A worldwide literature survey cites power generation by direct conversion with solar cells and indirect conversion using solar heat. Topic areas cover solar tower power plants, orbital solar energy technology, photovoltaic power generation, and solar augmentation of hydroelectric power systems. A few abstracts pertain to the future role that solar energy will play in production of electric power and general studies comparing the technical and economic feasibility of various methods of electric power generation. Abstracts dealing with solar sea power generation and spacecraft power supplies are excluded.

(SOLAR-OVERVIEW)

ST77 11020 SOLAR ELECTRIC POWER GENERATION (CITATIONS FROM THE NTIS DATA BASE)

Hundemann, A.S., (NTIS, Springfield, VA), 222 p., Oct 1976, NTIS/PS-76/0796/3WE, PCS25.00/MFS25.00

Abstracts of Federally-funded research pertaining to terrestrial electric power generation by both direct conversion with solar cells and indirect conversion using solar heat are presented. Topic areas cover equipment design, site surveys, economics, and feasibility studies. Abstracts dealing with solar sea power generation and spacecraft power supplies are excluded.

(SOLAR-OVERVIEW)

ST77 11021 "SOLAR ENERGY - FUEL AND FOOD" WORKSHOP

Jensen, M.H., 262 p., Apr 5-6, 1976

Avail: Environmental Research Laboratory, The University of Arizona, in cooperation with ERDA, and U.S. Department of Agriculture, Agricultural Research Service

The utilization of solar energy in greenhouses and integrated greenhouse-residential systems.

(SOLAR-OVERVIEW, PROCEEDINGS, GREENHOUSES)

ST77 11022 THE STATUS AND PROSPECTS OF SOLAR ENERGY

Justi, E., (Braunschweig, Technische Universitaet, Braunschweig, West Germany), Deutsche Gesellschaft Fuer Sonnenenergie, Graefelfing, West Germany, p. 3-34, 1976, In Solar Heating; Meeting, 1st, Goettingen, West Germany, Feb 23-24, 1976, Reports, A76-45301 23-44, A76-45302, In German

It is shown that the amount of solar energy received on earth is more than sufficient to satisfy any conceivable energy requirements of human civilization. Approaches for providing energy with the aid of solar cells have to overcome disadvantages related to the high costs of solar cell production. Thermal approaches requiring a concentration of solar radiation have certain operational disadvantages. Methods utilizing planar radiation collecting devices which do not suffer from these disadvantages are discussed. Attention is given to solar heating in the area of residential housing, solar power stations producing hydrogen as energy carrier in the south of Europe, and the superiority of bioenergetic systems based on photosynthetic reactions.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY, FORECASTING)

ST77 11023 FUSION AND SOLAR ENERGY - POTENTIAL ALTERNATIVE ENERGY SOURCES?

Kemeny, L.G., (Univ of NSW, Australia), Inst of Eng, Australia; Annu Eng Conf, Townsville, May 10-14, 1976, Publ by Inst of Eng, Australia, Sydney, Pap 362/1, p. 16-24, 15 refs, 1976

The paper reviews the present status and future prospects of fusion and solar energy sources in terms of technology and economic prospects.

(SOLAR-OVERVIEW, ECONOMICS)

ST77 11024 UTILIZATION OF SOLAR ENERGY

Kleinkauf, W., (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln, F.R. Germany, Inst. fuer Energiewandlung und Elektrische Antriebe), 17 p., 1976, ERDA-tr-144, Translation of German report

The production of high-temperature heat in the Federal Republic of Germany is not cost effective owing to the availability of a duration of sunshine of ca. 1500 h/a. The substitution of previous energy carriers for production of low-temperature heat, nevertheless, is also still available at these latitudes. Especially suited for this are decentralized units with flat collector systems for supplying single and two-family houses. The energy production with low-temperature collectors can be estimated for the year 2000 at ca. 100 TWh/a. If higher solar energy yields are required owing to the shortage as well as the steadily increasing costs of previous energy carriers or owing to ecological viewpoints, it follows that sunny regions of the south become involved as locations for solar power plants. If the regions of North Africa are included in the considerations, it follows that there is a considerably large energy potential available which could also cover the energy requirement of the Federal Republic of Germany as well as that of Western Europe. Basic condition for this is intensive collaboration with countries in sunny regions.

(SOLAR-OVERVIEW, CONVERSION, GERMANY)

ST77 11025 SOLAR ENERGY OPTIONS FOR ELECTRIC UTILITIES

Leon, H.I., Gorman, R., Dawley, R., (TRW Systems, McLean, VA), New York, Institute of Electrical and Electronics Engineers, Inc., p. 76-78, 1976, In Engineering in a Changing Economy; Proceedings of the Southeast Region 3 Conference, Clemson, SC, Apr 5-7, 1976, A76-47201 24-99, A76-47208

Four solar electric technologies for utilities are examined solar thermal, solar photovoltaic, ocean thermal, and wind conversion. The technologies are assessed and compared by defining a baseline of conventional plants, the solar electric plant objectives for performance, capital cost and year of commercial availability, and a standard set of economic measures to calculate bus bar cost.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

ST77 11026 SOLAR ENERGY PROSPECTS FOR ELECTRIC POWER GENERATION IN BRAZIL

Magnoli, D., (Centro De Tecnologia Promon, Rio De Janeiro, Brazil), New York, American Institute of Chemical Engineers, V 2:1224-1231, 1976, In Intersociety Energy Conversion Engineering

Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662  
02-44, A77-12805

A review of the energy prospects for electric power generation in Brazil indicates that hydraulic resources offer the best possibilities. However, Brazil's hydroelectric potential, both known and assumed, lies in the north, which is far away from the country's developed centers and where settlement is difficult. Exploitation of other resources for electric power generation is necessary before 1990. The discussion covers electric power in the northeast region, prospects of the use of solar energy in the northeast region, configuration of helio-electric systems in prospect, and capacity of the Brazilian industry for manufacture of solar power plant components and applied research programs. There is sufficient R&D basis for installation of small power plants based on biomass energy. Installation of large-scale solar power plants would require applied research programs regarding processes, materials, and development of adequate equipment.

(SOLAR-OVERVIEW)

ST77 11027 PROSPECTS FOR SOLAR ENERGY UTILIZATION IN IRAN - PHOTOTHERMAL METHODS

Mansoori, G.A., (Illinois, University, Chicago, IL), Iranian Journal of Science and Technology, V 5:55-73, N2, 1976, A77-11532

The paper reviews the state of the art of photothermal methods of solar energy utilization and examines the technical and economic feasibility of adopting photothermal methods in Iran. Attention is given to the following methods space and water heating, agricultural crop and vegetable drying, water desalinization and distillation, cooking, heat actuated heat pumps; space cooling and heating, water pumping in arid areas, conventional steam turbines for power generation, dissociation of water for the production of hydrogen, advanced MHD and gas turbine processes, solar furnaces, and thermoelectric and thermionic converters.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

ST77 11028 SOLAR ENERGY AND THE ERDA PLAN FOR RESEARCH, DEVELOPMENT AND DEMONSTRATION

Marvin, H.H., (ERDA, Div. of Solar Energy, Washington, DC), Washington, DC, Government Institutes, Inc., p. 129-134, 1976, In Energy Technology III - Commercialization; Proceedings of the Third Conference, Washington DC, Mar 29-31, 1976, A76-45226 23-44, A76-45238

The ERDA solar energy program is discussed. Attention is paid to solar heating and cooling, process heat, wind energy conversion, solar thermal conversion, photovoltaic energy conversion, ocean thermal energy conversion, and biomass energy conversion.

(SOLAR-OVERVIEW, UNITED-STATES)

ST77 11029 ENVIRONMENTALLY APPROPRIATE TECHNOLOGY - 2

McCallum, B., (Environment Canada), Eng J, Montreal, V 59:27-36, N1, Jan-Feb 1976

Growing numbers of scientists believe that solar energy is the only energy form that can provide us with non-polluting and non-depletable energy. Studies and actual experiments are being conducted in Canada, the U.S., Japan, Britain, France, The Netherlands, West Germany, and probably numerous other countries. Most of these countries are interested in using solar energy for heating purposes. However, in the U.S., there are a number of feasibility studies of large-scale electricity generating systems as well as research into solar space heating and cooling. They have greatly increased the funding for research into solar and solar-related energy sources (wind and biomass).

(SOLAR-OVERVIEW, INTERNATIONAL)

ST77 11030 SOLAR MICROCLIMATOLOGY

Mckenney, D.B., Beauchamp, W.T., (Helio Associates, Inc., Tucson, AZ), NASA-CR-148533, 71 p., Nov 1975, N76-28738/2WE, PCS4.50/MF\$3.00

It has become apparent in recent years that solar energy can be used for electric power production by several methods. Because of the diffuse nature of the solar insolation, the area involved in any central power plant design can encompass several square miles. A detailed design of these large area collection systems will require precise knowledge of the local solar insolation. Detailed information will also be needed concerning the temporal nature of the insolation and the local spatial distribution. Therefore, insolation data was collected and analyzed for a network of sensors distributed over an area of several square kilometers in Arizona. The analyses of this data yielded probability distributions of cloud size, velocity, and direction of motion which were compared with data obtained from the National Weather Service. Microclimatological analyses were also performed for suitable modeling parameters pertinent to large scale electric power plant design. Instrumentation used to collect the data is described.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY, ENVIRONMENT)

ST77 11031 DEVELOPMENTS IN SOLAR ENERGY UTILIZATION IN THE UNITED KINGDOM

McVeigh, J.C., (Brighton Polytechnic, Brighton, England), Solar Energy, V 18:381-385, N5, 1976, CONF-750712-10, A77-12402

The paper outlines the main lines of research and development currently being undertaken in the United Kingdom for solar energy applications. A brief discussion of the radiation climate is included, along with a review of activities in the photovoltaic, photochemical, and photobiological fields. Wind power is also receiving renewed interest. A major conclusion is that many workers believe solar energy can make a significant contribution to the energy requirements of the country, although this is not as yet the official government viewpoint.

(SOLAR-OVERVIEW)

ST77 11032 STATUS OF SOLAR ENERGY UTILIZATION IN AUSTRALIA FOR INDUSTRIAL, COMMERCIAL, AND DOMESTIC PURPOSES

Morse, R.N., Cooper, P.I., Proctor, D., (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), 48 p., July 1974, S.E.S.-74/1, U.S. Sales Only

The status of solar energy utilization in Australia for industrial, commercial, and domestic purposes is discussed in terms of existing installations, planned installations, solar equipment manufacturers, completed research projects, and current research programs.

(SOLAR-OVERVIEW)

ST77 11033 STRATEGY FOR SOLAR ENERGY RESEARCH IN AUSTRALIA

Morse, R.N., (Commonwealth Scientific and Industrial Research Organization, East Melbourne, Australia), 14 p., 1975, CONF-751178-1, PCS3.50/MF\$3.00, U.S. Sales Only

Solar energy could, by the end of the century, be making an important contribution to Australia's primary energy if it is given the necessary support now. It can do this, firstly, by solar heat generating systems, integrated with conventional fuels, supplying heat for industrial processes. Secondly, cellulose produced by photosynthesis can be converted to ethanol, which is a liquid fuel suitable for motor vehicles. The combination of solar-generated heat and renewable fuels such as ethanol could provide a permanent replacement for fossil fuels. The research programs needed to make this possible would involve a considerable expansion of the present effort and would include projects concerned with the collection of solar energy, storage of heat, energy transfer, and systems and applications engineering. The renewable fuels program would be a multi-disciplinary one, incorporating projects on forest and crop productivity, land use, environment impact, energy efficiency, improvements to hydrolysis and fermentation processes, and applications engineering. The program, to be fully effective, should involve industrial laboratories, universities, and colleges of advanced education, as well as government research laboratories on a scale needed to lay the foundation for two new major industries.

(SOLAR-OVERVIEW, CONVERSION)

ST77 11034 SOLAR ENERGY: L-DIVISION MISCELLANEA

Neifert, R.D., (California Univ., Livermore, CA), 11 p., May 27, 1976, UCID-17177

This report summarizes some of the capabilities that have been developed within L-Division related to the use of solar energy for heating of buildings, electrical generation, and/or process heat. To date, these capabilities have been primarily directed towards studies related to the Sohio Process Heat Facility project. However, they would be applicable to a wide variety of solar energy projects, and therefore, are presented for information and review. A stand-alone data acquisition system has been developed for the purpose of measuring instantaneous solar radiation and ambient air temperature. In addition, a compact, mobile calibration system is available to cross-calibrate solar instruments in-situ. Solar radiation data has been collected and analyzed since January 1974. Data are available for total instantaneous insolation, total daily insolation and monthly-average total daily insolation. Several computer codes are available for parametric performance studies of process heat facilities and calculating collection efficiency for a shallow solar pond.

(SOLAR-OVERVIEW, INSOLATION-DATA)

ST77 11035 PRODUCTION OF CHEMICAL ENERGY CARRIERS BY NON-EXPANDABLE ENERGY SOURCES - SOLAR ENERGY ELECTROLYSIS, PHOTOLYSIS, AND THERMOCHEMICAL CYCLES

Nitsch, J., (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Lampoldshausen, West Germany, Inst. fuer Chemische Raketenantriebe), 45 p., Report will also be announced as Translation ESA-TT-338, DLR-FB-76-32, N77-13541, In German; English Summary  
Avail:NTIS

The different forms of energy (radiation, high-temperature heat, and electricity) arising from non-expandable energy sources like solar energy can be used for the production of chemical energy-carriers. Possible methods are the splitting of water by means of photolysis, thermochemical cycles, and electrolysis, as well as the storage of energy in closed loop chemical systems. These methods are described, and efficiencies and costs of the production of these

energy carriers are specified. Special problems of the long-distance transportation of hydrogen produced by solar energy are described and the resulting costs estimated.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

ST77 11036 UTILIZATION OF SOLAR POWER - A NEW DEPARTURE

Paiz, W., (Centre National D'Etudes Spatiales, Paris, France), Revue Francaise De L'Electricite, 3rd Quarter, V 49:6-13, 1976, A77-15049, In French

Current applications for solar power, and particularly solar energy facilities based on solar photocells, in France, new directions in utilization of solar cells, and the history of solar power utilization along various lines, are discussed. Non-electrical use of solar power in water heaters and residence heating is discussed with its limitations, in addition to solar engines, solar energy power stations, and solar pumps. Direct conversion via photocells, with the advantages of minimal maintenance, no moving parts, and usefulness in cold climates, is stressed, and future applications of solar cells are projected. A breakeven time of 3-5 years for solar power water heaters is reported.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY, FRANCE)

ST77 11037 FLORIDA SOLAR ENERGY CENTER

Phillips, W.B., (State Univ Syst of FL), Technol Today for Tomorrow, Publ by Canaveral Council of Tech Soc, Cape Canaveral, FL, p.5, 1-5, 4, 1975, Space Congr, 12th, Proc, Cocoa Beach, FL, Apr 9-11, 1975

The Florida Solar Energy Center, established under the direction of the Florida Board of Regents, is designed to serve as a central facility for solar energy activities of the state's nine public universities, as well as private institutions which choose to participate. Activities of the Center will include research, development, information dissemination, and demonstration projects. The Center will include Divisions of Research, Development, Tests and Standards, Education, Information, and Technical Assistance. The site consists of 20 acres on the water at Port Canaveral and adjacent to the Kennedy Space Center. Four existing buildings including an auditorium, laboratories, offices, a library, TV studios, and classrooms will be used for the initial operations of the Center.

(SOLAR-OVERVIEW, DEMONSTRATIONS)

ST77 11038 THE LONG-RANGE PROSPECTS FOR SOLAR ENERGY

Pollard, W.G., American Scientist, V 64:424-429, July-Aug 1976, A77-12237

An attempt is made to evaluate the long-range potential of various ways of using solar energy. Assuming the technology to be successfully established, the question is posed whether solar energy systems can be commercially feasible as a practical component of the nation's energy system in competition with alternative energy sources. In discussing direct uses of solar radiation, including solar heating and solar electricity systems, the energy conversion efficiency, problems related to low intensity and intermittency of solar energy are analyzed, as well as land requirements for solar-electric power plants. The major trends and prospects of wind power plants, and the Ocean Thermal Energy Conversion (OTEC) system are examined as examples of indirectly used solar energy. Attention is also given to space-based solar electric systems. It is concluded that neither direct nor indirect solar energy (other than hydroelectric) can make a substantial contribution to the nation's large-scale energy needs. Potential of solar energy is found to be significant only for small self-contained total energy systems for rural homes and farms, or in remote locations where the cost factor is not important.

(SOLAR-OVERVIEW, ECONOMICS, UNITED-STATES, PESSIMISTIC-OUTLOOK)

ST77 11039 COMBINATION METHOD FOR CONSTRUCTING PERFORMANCE-CONFIDENCE CURVES FOR THE COMBINED OPERATION OF SOLAR AND WIND-DRIVEN POWER PLANTS

Salieva, R.B., (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR), Geliotekhnika, p. 52-56, N4, 1976, A76-47109, In Russian

An equation of the integral performance probability for combined solar and wind-driven plants, referred to as the performance-confidence curve, is analyzed. The analysis is carried out by a combination method of constructing probability distribution functions, based on operational independence of the two components (the performances of the solar and wind-driven plants). Solutions are obtained from direct observational data on the component performances, without recourse to extrapolation. The resultant curve of the total performance is compared with the same curve plotted by simulation of observational results. Both curves coincide within the error of graphical methods.

(SOLAR-OVERVIEW)

ST77 11040 EVALUATION OF THE RELIABILITY OF POWER SUPPLY FROM REGENERATING ENERGY SOURCES BY MEANS OF BIMODAL DISTRIBUTION CURVES - SOLAR AND WIND SYSTEMS FOR RADIO RELAY LINKS

Salieva, R.B., (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR), Geliotekhnika, p. 57-62, N4, 1976, A76-47110, In Russian

Power supply of radio-relay communication lines by solar or wind energy sources is supplemented by accumulators operating during the periods of cloudy or windless weather. An attempt is made to construct a mathematical model of the process for use as a basis in developing automatic control of such power supply systems. The distribution function for the duration of continuous operation of the accumulators is described using the statistical method of moments. The analysis of observational data showed that the curves of the distribution functions have a bimodal shape. A method of analysis for such curves is proposed. Equations describing the curves are derived, a computer algorithm for solving these equations is worked out, and the numerical solutions obtained are analyzed.

(SOLAR-OVERVIEW, CONTROL-SYSTEM, COMPUTER-PROGRAM)

ST77 11041 SOLAR ENERGY NOW: WHY AREN'T WE USING IT MORE?

Tobias, A., New West, V 1:32-39, N4, June 7, 1976

Solar energy applications run the gamut. Some of them are simple, reliable, and economically compelling right now.

(SOLAR-OVERVIEW, INSTITUTIONAL-RESTRAINTS, CONVERSION-TECHNOLOGY)

ST77 11042 SOLAR TOTAL ENERGY PROGRAM SEMIANNUAL REPORT, OCTOBER 1975-MARCH 1976

Treadwell, G.W., Torkelson, L.E., (Sandia Labs., Albuquerque, NM), 64 p., June 1976, SAND-76-0205, PCS4.50/MFS3.00

This report describes the activities of the Sandia Laboratories Solar Total Energy Program during the 6-month period, October 1975 through March 1976. Included are highlights of the period, descriptions of the system and its components, including recent modifications, and the results of systems analyses and component testing.

(SOLAR-OVERVIEW, SANDIA-LABS)

ST77 11043 SOLAR ENERGY APPLICATIONS - 1976

Yellott, J.I., Princeton, NJ, Electrochemical Society, Inc., p. 1-15, 1976, In International Symposium on Solar Energy, Washington, DC, May 5-7, 1976, Proceedings, A76-47051 24-44, A76-47052

The three basic domains of heliotechnology are characterized, namely, heliochemical, heliothermal, and helioelectrical processes, and some of the more successful concepts that have been realized or are under development for converting the sun's radiant energy to useful heat for space and water heating (and cooling), are briefly described. The economic desirability of solar water heating as opposed to conventional water heating is explained. The concepts of passive and active systems for space heating are examined, and active systems using air or based on rock-pile storage are described. The two currently explored concepts for developing heliothermal cycles for generation of large quantities of power are outlined, namely, the use of long arrays of parabolic troughs that reflect solar rays to absorbers, and the use of a steam generator mounted atop a tall tower and receiving radiant energy from thousands of heliostats around it.

(SOLAR-OVERVIEW, CONVERSION-TECHNOLOGY)

## 12,000 ECONOMICS AND LAW

ST77 12000 THE COST OF ENERGY FROM UTILITY-OWNED SOLAR ELECTRIC SYSTEMS. A REQUIRED REVENUE METHODOLOGY FOR ERDA/EPRI EVALUATIONS

(Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA), NASA-CR-148493, 89 p., June 1976, JPL-5040-29, N76-28647/5WE, PCS5.00/MFS3.00

This methodology calculates the electric energy busbar cost from a utility-owned solar electric system. This approach is applicable to both publicly- and privately-owned utilities. Busbar cost represents the minimum price per unit of energy consistent with producing system-resultant revenues equal to the sum of system-resultant costs. This equality is expressed in present value terms, where the discount rate used reflects the rate of return required on invested capital. Major input variables describe the output capabilities and capital cost of the energy system, the cash flows required for system operation and maintenance, and the financial structure and tax environment of the utility.

(ECONOMIC-OVERVIEW)



ST77 12001 ENGINEERING IN A CHANGING ECONOMY; PROCEEDINGS OF THE SOUTHEAST REGION 3 CONFERENCE, CLEMSON, SOUTH CAROLINA, APRIL 5-7, 1976

(Conference Sponsored by the Institute of Electrical and Electronics Engineers), New York, Institute of Electrical and Electronics Engineers, Inc., 400 p., 1976, A76-47201, Members \$21.00, Nonmembers \$28.00

A variety of topics are treated including power technology, digital systems, computer applications, electromagnetic fields, semiconductor technologies, solar electric energy, digital signal processing, control theory, radar, solid state applications, and microprocessor computer systems. Attention is also given to microprocessor computer systems, biological pattern processing, microelectronics, laser inertial navigators, communication systems, control computers, aerospace electronics and systems, large scale systems, bioinstrumentation, communication signal processing, and noise in semiconductor devices.

(ECONOMIC-OVERVIEW)

ST77 12002 FEASIBILITY OF AN ENERGY OUTREACH PROGRAM. FINAL REPORT

(ERDA, Washington, DC), 59 p., Jan 14, 1976

The approach to developing a feasible energy outreach program followed a conceptual approach that involved first identifying and characterizing target markets for energy conservation information and assistance, and then defining products of services to meet those markets' needs. Implementation of this approach involved seven major steps. The seven steps - segment the market; find a market niche; postulate a product line; conduct market research; define the product line; prepare the business plan; and analyze the return on investment - are discussed in detail and displayed graphically.

(MARKET-OVERVIEW, ECONOMICS)

ST77 12003 REPORT TO CONGRESS ON THE ECONOMIC IMPACT OF ENERGY ACTIONS

(FEA, Washington, DC), 64 p., June 1976, FEA/B-76/384, PB-257 697/3WE

This report addresses the individual actions taken by FEA during the period from July 1, 1975, to March 31, 1976, as analyzed within the Inflationary Impact Evaluation process. An Inflationary Impact Evaluation (IIE) is an individual report of the likely impact on energy prices, the consumer price index, and other economic variables, of actions proposed by the Administrator of FEA.

(INFLATION)

ST77 12004 TECHNOLOGY EVALUATION REPORT FOR COMMERCIAL DEMONSTRATION PROGRAM. EXECUTIVE SUMMARY

(General Electric Co., Philadelphia, PA), 20 p., Apr 1976, COO/2683-76/6

This document contains a summary of the General Electric National Solar Demonstration Program, Technology Evaluation Report. The report assesses status and availability of solar heating and cooling equipment for inclusion in ERDA's "Commercial Demonstration Program" commensurate with ERDA 23A. Criteria have been developed which are to be met by solar hardware incorporated into the demonstration program. Assessments have been made, based on a survey of solar hardware manufacturers and developers, of when components, subsystems, and systems will be available for demonstration according to the technology status categories set forth in ERDA 23A.

(ECONOMICS, MANUFACTURERS-SURVEY, EQUIPMENT-AVAILABILITY)

ST77 12005 TURNING TOWARD THE SUN. VOLUME 1 - ABSTRACTS OF STATE LEGISLATIVE ENACTMENTS OF 1974 AND 1975 REGARDING SOLAR ENERGY

(National Conference of State Legislatures, Denver, CO), NSF/RA/G-75-052-Vol-1, NSF ISR-1552, V 1:47, PB-252836/2, N76-32676  
Avail:NTIS HCS4.00

This report identifies and abstracts all state enactments in 1974 and 1975 that directly relate to improving the prospects for solar energy applications. Specific areas of coverage are property income and sales tax incentives, state financed energy research and development of solar technologies, life-cycled cost analysis, solar provisions in state building codes, access to incident solar energy, and solar energy informational and promotional activities. State financed buildings using solar energy, and selected solar energy publications are also described briefly.

(LAW, UNITED-STATES)

ST77 12006 RELATIONSHIP OF ENERGY GROWTH TO ECONOMIC GROWTH UNDER ALTERNATIVE ENERGY POLICIES

Behling, D.J., Jr., Dullien, R., Hudson, E., (Brookhaven National Lab., Upton, NY), 247 p., Mar 1976, BNL-50500

This report is the first of a series of studies that will analyze the economic and social impacts of research, development, and demonstration plans of the Energy Research and Development Administration. Two policy proposals were examined against a Base Case set of economic and energy projections for the years 1985, 1990, and 2000: (1) the introduction of RD and D-initiated energy supply and end-use conversion technologies to expand domestic energy supply and to improve the efficiency and flexibility of its use; and (2) the imposition of taxes and tariffs on petroleum and natural gas to reduce demand for these primary energy sources. Targets for the amounts of imports of oil and gas were specified by ERDA as follows: 10 percent (or less) of total U.S. energy consumption in 1985; 8 percent (or less) of total U.S. energy consumption in 1990; and 5 percent (or less) of total U.S. energy consumption in 2000. The purpose of the analysis was to first identify the degree to which the introduction of new energy technologies and/or the imposition of energy taxes could reduce oil and gas imports toward the target levels; and second, to estimate the effects of these policies on the economy and the environment. These economic and environmental effects are thus a measure of the costs associated with meeting the import targets. The benefits of these policies, in the form of increased economic and political security were not measured. The analysis was based on an analytic framework which linked detailed mathematical process engineering and economic models to more aggregate econometric models. The four models employed are described.

(SOCIAL-IMPACTS, ENVIRONMENT)

#### ST77 12007 COST ASPECTS OF SOLAR ENERGY - SELECTIVE AND CRITICAL BIBLIOGRAPHY

Cavard, D., Criqui, P., *Revue De L'Energie*, V 27:533-540, Nov 1976, A77-15799, In French

Contributions to the literature on solar energy are selected for their coverage of economic and social aspects of the problem, in addition to relevance to ecological impact and accessibility to the nontechnical reader. The annotated bibliography is organized in groups of entries offering (1) introductory tutorial review treatments of the overall topic; (2) proceedings of relevant conferences; (3) periodicals; (4) specific solar energy technologies or modes of utilization of solar energy (residence heating, photovoltaic conversion, distillation, direct thermal systems); (5) institutional and legal aspects; (6) research and development; (7) relevant meteorological information. Cost aspects are broached in the strict sense (cost competitiveness of systems) and in the larger sense (social costs and collective advantages or penalties).

(ECONOMIC-OVERVIEW, ENVIRONMENT)

#### ST77 12008 SOLAR ENERGY ECONOMICS - THE A PRIORI DECISION

Clark, J.A., (Michigan, University, Ann Arbor, MI), *International Journal of Heat and Mass Transfer*, V 19:1095-1106, Oct 1976, A76-45851

The initial decision concerning the economic viability of a solar energy heating system is shown to involve technical, physical, meteorological, geographic, design and cost factors as well as the source of funding and type of arrangements made to finance the system. Four economic/technical models, which include the influence of increasing fuel costs, are presented and compared with other possible kinds of investments to determine the economic viability of the system. It is found that different economic conclusions are both possible and justifiable for investment situations having different constraints.

(HEATING, SYSTEM-INVESTMENTS, FINANCING)

#### ST77 12009 ECONOMIC-ENERGETIC ANALYSIS IN THE FIELD OF UNCONVENTIONAL THERMAL ENERGY - THE POSSIBILITIES AND LIMITATIONS OF GEOTHERMAL AND SOLAR ENERGY

De Comelli, G., (Trieste, Università, Trieste, Italy), Rome, *Rassegna Internazionale Elettronica Nucleare Ed Aerospaziale*, p. 561-572, 1976, In International Scientific-Technological Conference on Space, 16th, Rome Italy, Mar 18-20, 1976, Proceedings, A76-45951 23-12, A76-45997, In Italian

The main purpose of this paper is to survey the present state of the practical employment of geothermal and solar energy. Geothermal and solar energy are examined in order to point out the natural limits of their practical availability and the technological obstacles to their employment. The most important results obtained in the utilization of the two sources of energy considered are summarized.

(CONVERSION-EFFICIENCY)

#### ST77 12010 A SURVEY OF STATE LEGISLATION RELATING TO SOLAR ENERGY

Eisenhard, R.M., (National Bureau of Standards, Washington, DC), 166 p., Apr 1976, NBSIR-76-1082, PB-258 235/WE, PC\$6.75/MF\$3.00

This report reviews enacted state legislation dealing with solar energy. Acts involving tax incentives, reduced property assessments, research and development, solar easements and solar energy promotion are identified and abstracted. The responsible state agency and official are listed. Acts and supporting forms and other information are included. Portions of this document are not fully legible.

(LAW, TAX INCENTIVES, PROPERTY ASSESSMENTS)

ST77 12011 COST STUDIES ON TERRESTRIAL PHOTOVOLTAIC POWER SYSTEMS WITH SUNLIGHT CONCENTRATION

Evans, D.L., Florschuetz, L.W., (Arizona State Univ, Tempe, AZ), Int Sol Energy Congr and Expo, Extended Abstr: Sol Use Now - A Resour for People, University of California, Los Angeles, CA, p. 114-115, July 28-Aug 1, 1975, Publ by ISES, Smithsonian Rad Biol Lab, Rockville, MD, 1975

The role of sunlight concentration in reducing the cost of electrical energy generated by terrestrial photovoltaic systems is defined. The study explores an alternative to the deployment of large areas of cells in flat unconcentrated arrays. A system simulation algorithm has been developed to calculate the amount of electrical energy produced over a year's time by alternative photovoltaic systems. Energy costs are calculated by the levelized fixed charge method.

(ECONOMICS, MATHEMATICAL MODEL)

ST77 12012 RESEARCH AND DEVELOPMENT OF LOW COST PROCESSES FOR INTEGRATED SOLAR ARRAYS. QUARTERLY REPORT NO. 1, MAY 12, 1976-JUNE 18, 1976

Graham, C.D., Jr., Kulkarni, S., Noel, G.T., Pope, D.P., Pratt, B., (Pennsylvania Univ., Philadelphia, PA), 27 p., ERDA/JPL/954506-76/1

Progress on a program to determine the conditions under which sheets of silicon might be produced by a rolling process is described. Uniaxial compression experiments are used to characterize the deformation properties of polycrystalline silicon at various temperatures and strain rates. Crystallographic texture studies of samples at various stages has shown that considerable recrystallization occurs as a result of compression and annealing. The resulting material has a cubic texture. Experiments to date have covered the strain rate range  $10 \exp -4$  to  $10 \exp -1$  and the temperature range 1200 to 1400 exp 0 C. A rolling speed of the order of 180 ft/hr is predicted on the basis of current data. A new apparatus capable of strain rates two orders of magnitude higher than those used to date is being readied for use in these studies.

(ECONOMICS, PROCESS-REVIEW)

ST77 12013 ECONOMIC ANALYSIS OF THE NEED FOR ADVANCED POWER SOURCES

Hardie, R.W., Omberg, R.P., (Hanford Engineering Development Lab., Richland, WA), 17 p., Presented at Am. Nucl. Soc. 1975 Winter Meeting, San Francisco, Nov 16-21, 1975, HEDL-SA-989, CONF-751101-77, AT(45-1)-2170, N77-15509  
Avail:NTIS

The economic need for an advanced power source, be it fusion, solar, or some other concept, is considered. However, calculations were also performed assuming abandonment of the LMFBR program, so breeder benefits are a by-product of this study. The model used was the Alps Linear Programming system for forecasting optimum power growth patterns. Total power costs were calculated over a planning horizon from 1975 to 2041 and discounted at 7½ percent. The benefit of a particular advanced power source is simply the reduction in total power cost resulting from its introduction. Since data concerning advanced power sources (APS) are speculative, parametric calculations varying introduction dates and capital costs about a hypothetical APS plant were performed. Calculations were also performed without the LMFBR to determine the effect of the breeder on the benefits of an advanced power source.

(FORECASTING, COMPUTER-MODEL)

ST77 12014 ECONOMIC STUDY OF SOLAR TOTAL ENERGY

Harrigan, R.W., (Sandia Labs., Albuquerque, NM), 15 p., 1976, CONF-760821-1, SAND-76-5291

This paper investigates the application of solar total energy to a 2000-dwelling-unit mixed-load community. The community design is consistent with current community planning practices. An energy analysis of the community was performed and a solar total energy system sized to meet the community demands. The economics of providing a solar total energy system is examined. The effect of dwelling-unit density is examined.

(COMMUNITY-DEVELOPMENT)

ST77 12015 SIMULATION OF NONLINEARITIES WITH THE AID OF MIXED-INTEGRAL LINEAR OPTIMIZATION AND ITS APPLICATION IN THE ENERGY ECONOMY

Heil, G., (Kammer Der Technik, Institut fuer Energieversorgung, Dresden, East Germany), Energietechnik, V 26:349-353, Aug 1976, A76-47712, In German

A description is presented of an approach for the piecewise linearization of cost functions with arbitrary curvature characteristics, taking into account mixed-integral optimization methods. Attention is given to the basic forms of a cost function, the method of mixed-integral optimization as an aid in the solution of minimization problems with a concave cost function, and an evaluation of the results obtained in an application of the considered approach.

(ECONOMIC-OVERVIEW)

Laitner, S., 11 p., 17 refs, Conference on Energy Efficiency, Washington, DC, May 20-21, 1976  
 Avail:TAC

The relationship between energy and jobs and the economy is, at best, a confusing one. Because the number of persons employed and the size of the economy, as measured by the Gross National Product (GNP), historically has grown as non-human energy consumption has increased, business and industry leaders argue that more energy is a prerequisite for higher employment levels. But this is a crude comparison and does not stand up to careful analysis.

(ECONOMIC-OVERVIEW)

ST77 12017 RESIDENTIAL SOLAR HEATING AND COOLING CONSTRAINTS AND INCENTIVES. A REVIEW OF THE LITERATURE

Little, A.D., (Arthur D. Little, Inc., Cambridge, MA), 248 p., May 1976, ADL-C-78534, PB-258  
 238/SWE, PCS8.00/MFS3.00

This report provides a comprehensive review and assessment of the literature on market constraints on solar heating and cooling and possible governmental incentives to overcome them. It points out major gaps and omissions in the existing literature on constraints and incentives and makes recommendations to the Department of Housing and Urban Development (HUD) for further research. Five categories of constraints are analyzed: economic/financial, technical, social/political, institutional/industrial and regulatory/legal. Incentives are examined in terms of their potential usefulness and feasibility in overcoming constraints in light of practical limits on governmental policy.

(ECONOMICS, MARKETS, LAW)

ST77 12018 BUSINESS ANALYSIS OF SOLAR PHOTOVOLTAIC ENERGY CONVERSION

Maycock, P.D., Wakefield, G.F., (Texas Instrum Inc, Dallas, TX), Conf Rec of the IEEE Photovoltaic Spec Conf, 11th, Scottsdale, AZ, May 6-8, 1975, Publ by IEEE, New York, NY, p. 252-255, 1975, Cat N75CH0948-OED

A design-to-cost analysis is used to develop the material and labor cost goals that must be met to allow profitable manufacture of solar photovoltaic panels that meet the Energy Research and Development Authority (ERDA) goals for 2000. An analysis of the solar panel market versus price per peak kw indicates very little market opportunity for industry until \$1000/peak kw prices are obtained. The selected strategy is extensive cost reductions to obtain \$200-\$500/kw panel costs. The approach developed in this paper is sufficiently broad so that it can be used to scope many other alternatives other than the silicon photovoltaic system selected.

(ECONOMIC-OVERVIEW)

ST77 12019 IS NUCLEAR ENERGY ECONOMICALLY VIABLE - COMPETITION WITH COAL

Perl, L.J., (National Economic Research Association, Inc., New York, NY), Energy, V 1:21-23, Summer-Fall 1976, A77-12933

An attempt is made to estimate the cost of electric energy generated both from coal- and nuclear-fired capacity in 1990. Regression equations are used to estimate capital costs for coal and nuclear capacity from 1980 to 1990. Estimated costs in 1990 of energy from the nuclear and coal plants under alternative SO2 control scenarios and at alternative capacity factors are discussed. A table describing coal demand based upon three alternative assumptions of electricity growth, nuclear capacity growth, and growth of solar and geothermal energy is presented.

(ECONOMIC-OVERVIEW, ALTERNATIVES)

ST77 12020 LAW AND SOLAR ENERGY SYSTEMS - LEGAL IMPEDIMENTS AND INDUCEMENTS TO SOLAR ENERGY SYSTEMS

Robbins, R.L., (Lake Michigan Federation, Chicago, IL), NSF APR-74-21034, Solar Energy, V 18:371-379, NS, 1976, International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, CA, July 28-Aug 1, 1975, A77-12401

Local and state law impediments as well as institutional constraints that have severely limited the change to solar energy systems for heating and cooling purposes are reviewed. Emphasis is placed on the activities that can take place in state and local governments to encourage use of solar energy. The areas of legal change include improving the access to solar insolation, optimizing the location of solar energy collectors, improving the public economics of solar energy systems, improving the operation and design of systems through feasible energy backup and utility concern with solar energy, removing potential construction and maintenance problems, financing solar energy systems, and allocating rights to solar insolation. Solutions that can be adapted to the problems of most states are recommended, although the suggestions still need to be matched to local conditions and legal precedent.

(INSTITUTIONAL CONSTRAINTS)

ST77 12021 LIFE-CYCLE COSTS AND SOLAR ENERGY

Ruegg, R., (NBS, Institute for Applied Technology, Washington, DC), ASHRAE Journal, V 18:22-25, Nov 1976, A77-13501

Techniques of life-cycle cost evaluation are examined as prospective means of assessing the cost effectiveness of solar energy systems as compared to rival energy systems. Acquisition costs (including system design, purchase, installation), system repair and replacement costs, maintenance and operating costs, and salvage values are considered in a present-value or annual-value model. Relevant tax policies and clean-energy incentives are also considered. A present-value evaluation model is presented in abbreviated form, incorporating direct costs (down payment, loan principal and interest), insurance costs, direct cost savings in value of fuel economized, property taxes and sales taxes, tax deductions, and incentives.

(ECONOMIC-OVERVIEW, TAXATION, INSURANCE)

ST77 12022 AN INDUSTRY VIEW OF SOLAR HEATING AND COOLING

Schmidt, R.N., (Honeywell, Inc., Minneapolis, MN), Washington, DC, Government Institutes, Inc., p. 163-171, 1976, In Energy Technology III - Commercialization; Proceedings of the Third Conference, Washington, DC, Mar 29-31, 1976, A76-45226 23-44, A76-45241

A brief review is presented of the status of solar heating and cooling in the United States. Discussions are presented on the need for economical solar systems and on the need for further research and development. The development of solar power plants is also discussed.

(ECONOMIC-OVERVIEW, UNITED-STATES)

ST77 12023 THE ECONOMICS OF SOLAR HOME HEATING

Schulze, W.D., Ben-David, S., Katson, R., Noll, S., Roach, F., Thayer, M., (University of New Mexico), Balcomb, J.D., (Los Alamos Scientific Laboratory, NM), Mar 13, 1977, A Study Prepared for the use of the Joint Economic Committee Congress of the United States, 95th Congress, 1st Session

Avail:U.S. Government Printing Office, Washington, DC, PCS1.35

Now that some experience has been gained both in manufacturing and installation of solar systems it is apparent that the cost of solar collectors installed, but excluding fixed costs, will be about \$10/ft<sup>2</sup>. Although this may seem high in comparison to estimates as low as \$3/ft<sup>2</sup> used in previous studies, we find that feasibility does occur for solar water and space heating systems between now and 1990 if either decontrolled prices of traditional energy sources are used as the basis of comparison or where curtailments of natural gas occur. The importance of this finding is diminished by the federal government's failure to assist in making capital available for energy conservation. If interest rates are kept high and if money (capital) remains in short supply, the prospects for capital intensive systems in homes, such as solar energy, are diminished greatly.

(REGIONAL-COMPARISONS, UNITED-STATES)

ST77 12024 SOLAR COLLECTOR MANUFACTURING ACTIVITY JANUARY THROUGH JUNE 1976

Stoll, R.D., (FEA, Washington, DC), 23 p., Sept 1976, FEA/B-76/403, PB-258 865/5WE, PCS3.50/MFS3.00

This report contains the results of a survey of private firms that have manufactured and sold solar collectors during the first half of calendar year 1976. The purpose of this semianual survey is to obtain descriptive statistics on economic activity in the solar heating and cooling area and to identify production growth rates in this fledgling industry. Results show that production during the first half of 1976 was 60 percent greater than for the last half of 1975 and 155 percent greater than for the first half of 1975.

(ECONOMICS)

## 13,000 THERMAL POWER

ST77 13000 CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, COLLECTOR SUBSYSTEM. QUARTERLY TECHNICAL PROGRESS REPORT

(Boeing Engineering and Construction, Seattle, WA), 90 p., Dec 31, 1975, SAN/1111-75/1

This document contains a description of the preliminary design baseline collector subsystem for a 10 MW/sub e/ solar thermal Pilot Plant. Also included are supporting data and analyses used in selecting the specific design, and results of research experiments in progress to verify the design. Each reflector in the collector subsystem is enclosed within a 7 meter (23 ft.) diameter, air-supported Tedlar dome. Tedlar for the baseline dome will be 0.15 mm (6 mils) thick and will be specially processed to obtain a smooth surface which will provide

high specular (direct) transmittance (86 to 90 percent). The reflector utilizes a commercially-available 0.05 mm (2 mils) thick Mylar film which is coated with vacuum-deposited aluminum on one surface. The drive and control system selected for the heliostats is a computer-controlled open-loop system utilizing incremental position feedback from optical encoders on each heliostat drive.

(THERMAL-POWER, HELIOSTATS, TRACKING-SYSTEM)

ST77 13001 CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM. COLLECTOR SUBSYSTEM, RESEARCH EXPERIMENTS QUARTERLY TECHNICAL PROGRESS REPORT

(Boeing Co., Seattle, WA), 92 p., Apr 20, 1976, SAN-1111-76-2

This document contains a description of the detail design (DD) of research experiment hardware to support the 10 MW/sub e/ Pilot Plant preliminary design (PD). Additionally, test plans for assembly, integration, and array tests are summarized along with results of completed component/material tests. Research experiment DD and tests described herein were planned to provide design verification and supporting data, with hardware which either duplicates, or closely simulates the Pilot Plant PD baseline.

(THERMAL-POWER, DESIGN-REVIEW)

ST77 13002 CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, PHASE 1. PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1975

(Martin Marietta Corp., Denver, CO), 486 p., Apr 1976, MCR-76-121, SAN/1110-76/T1

The program objective is the preliminary design of a 10 MWe pilot solar power plant supported by major subsystem experiments. Progress is reported on the following task elements: 10 MWe pilot plant; collector subsystem design and analysis; receiver subsystem requirements; receiver subsystem design; thermal storage subsystem; electrical power generation subsystem; and pilot plant architectural engineering and support.

(THERMAL-POWER, OVERVIEW)

ST77 13003 SOLAR PILOT PLANT, PHASE 1. QUARTERLY REPORT NO. 1, JULY-DECEMBER 1975

(Honeywell, Inc., Minneapolis, MN), 115 p., Feb 20, 1976, SAN/1109-76/T1

Honeywell Inc. is investigating the technical and economic feasibility of generating electricity from solar energy. During the first 6 months of the program (1 July-31 December 1975), a preliminary design baseline for a 10-MW(e) solar pilot plant was generated and analyzed. Subsequently, several changes were made to improve performance and/or reduce cost. Conceptual designs and research experiments were generated for three key subsystems - collector, steam generator, and thermal storage. Limited testing was done to study the problem of removing eutectic salts from vaporizer tubes in the thermal storage subsystem. The program was on schedule at the end of 1975. Plans for the first quarter of 1976 include ordering long-leadtime items for the subsystem research experiments, continuing analysis of the conceptual designs preparatory to detailing them, and continuing engineering model experiments.

(THERMAL-POWER, ECONOMICS)

ST77 13004 ENERGY CONVERSION SYSTEM

Banks, R.M., (ERDA, Washington, DC), 8 p., Filed Apr 11, 1974, patented Oct 21, 1975, This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing, Copy of patent available Commissioner of Patents, Washington, DC, PATENT-3 913 326, PAT-APPL-459 991, PCSO.50

The patent describes an engine for converting thermal energy to rotary mechanical work by alternating changes in configuration of thermally responsive elements composed of a thermal memory material. The elements are pivotally interconnected between a stationary pivot and a rotor which rotates about a fixed axis disposed eccentrically of the stationary pivot. Alternate heating and cooling of the thermally responsive elements to temperatures above and below, respectively, the predetermined critical temperature results in a torque about the fixed axis of the rotor.

(THERMAL-POWER, PATENT, HEAT-ENGINE)

ST77 13005 CHARACTERISTICS OF A SYSTEM FOR TRANSMITTING CONCENTRATED SOLAR RADIATION

Baranov, V.K., (Gosudarstvennyi Opticheskii Institut, Leningrad, USSR), Geliotekhnika, p. 15-25, N5, 1976, A77-14578, In Russian

The paper examines a system for transmitting concentrated solar energy over various distances, which uses hollow optical waveguides to gather rays in the output pupil after reflection from the waveguide walls. The relations between transmission capacity and the ratios of concentrator to waveguide diameter and waveguide length to concentrator geometry are investigated. The reflection coefficient of several waveguide materials (Cu, Al, and Ag) is studied.

(THERMAL-POWER WAVEGUIDES)

ST77 13006 SOLAR POWERED ORGANIC RANKINE CYCLE ENGINES - CHARACTERISTICS AND COSTS

Barber, R.E., (Barber-Nichols Engineering Co., Arvada, CO), New York, American Institute of Chemical Engineers, V 2:1151-1156, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12798

The technical and cost aspects of the organic Rankine cycle and its interaction with the solar collector as a power system are examined. It is shown that collector temperatures of 200, 300-400, and 600 F are optimum operating conditions for flat plate, concentrators, and tracking concentrators, respectively, with the peak solar conversion efficiencies of these systems, approximately 5, 10 and 11%. The dominant factor in system cost is shown to be the collector cost. It is estimated that the Rankine cycle cost will be about one third of the total system cost with two thirds going to the collector component. It is also estimated that the installed cost mass-produced solar power systems would be about 1600-2500 dollars/peak kw output.

(THERMAL-POWER ECONOMICS)

ST77 13007 TRANSIENT PERFORMANCE CHARACTERISTICS OF A HIGH TEMPERATURE DISTRIBUTED SOLAR COLLECTOR FIELD

Black, D.L., Ellis, J.F., (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, PA), New York, American Institute of Chemical Engineers, V 2:1264-1271, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada Sept 12-17, 1976, Proceedings, Volume 2, A77-12662 02-44, A77-12810

A mathematical model of a high temperature distributed solar collector field was used on a hybrid computer to study the transient performance characteristics. The heat transfer system consists of a series of reflector/absorber energy concentrating devices using therminol 66 coolant operating between a minimum cold storage temperature of 242 C and a hot storage temperature of 325 C. Control strategies were tested and controllers were developed which would maximize the daily energy delivered while maintaining a rigid tolerance of + or -1 C on its temperature. The results for different strategies included cold startup, sudden change in insolation, and malfunctions such as loss of pump. Continuous storage bypass and startup only were evaluated through the use of a high temperature auxiliary bypass accumulator loop. Analog flow controllers were developed from a model frequency response at the noon period operating conditions for the fall season.

(THERMAL-POWER, MATHEMATICAL MODEL)

ST77 13008 SOLAR HEATING SYSTEM FOR AIRPORT PAVEMENT SNOW, SLUSH, AND ICE CONTROL

Bromley, E., Jr., Daulerio, H., (FAA, Washington, DC), Pravda, M., (Dynatherm Corp., Los Angeles, CA), American Institute of Aeronautics and Astronautics, Inc., Vandenberg, CA, Western Periodicals Co., North Hollywood, CA, p. 58-69, 1976, In Symposium on Alternate Fuel Resources, Santa Maria, CA, Mar 25-27, 1976, Proceedings, A76-47287 24-44, A76-47293

The technical and economic practicability of a solar energy pavement heating system for use in snow, slush and ice control on airport runways, taxiways and ramps is discussed. The preliminary design considers the winter climate, the air traffic density and the operating and total system costs. Cost comparison between a solar, electrical and a steam fired system are given together with a 'snop' number which is unique to each airport. Through use of the 'snop' number, each airport management can predict when the practicality of a solar system should be considered.

(THERMAL-POWER)

ST77 13009 SOLAR THERMAL ELECTRIC POWER PLANTS - THEIR PERFORMANCE CHARACTERISTICS AND TOTAL SOCIAL COSTS

Caputo, R.S., Truscello, V.C., (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), New York, American Institute of Chemical Engineers, V 2:1216-1223, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12804

The central receiver (power tower) concept as a thermal conversion approach to the conversion of solar energy into electricity is compared to other solar power plant designs which feature distributed solar collection and use other types of solar collector configurations. A variety of solar thermal storage concepts are discussed and their impacts on system performance are assessed. Although a good deal of quantification is possible in a comparative study, the subjective judgments carry enormous weight in a socio-economic decision, the ultimate choice of central power plant being more a social than an economic or technical decision. Major elements of the total social cost of each type of central plant are identified as utility economic costs, R&D funds, health costs, and other relevant social impacts.

(THERMAL-POWER, CENTRAL-RECEIVER, STORAGE, COMPARISONS)

ST77 13010 CORRADIATION USING THE REVERSIBLE AMMONIA REACTION

Carden, P.O., (Australia Natl Univ, Canberra, Australia), Int Sol Energy Congr and Expo, Extended Abstr: Sol Use Now - A Resour for People, Univ of CA, Los Angeles, CA, p. 535-536, July 28-Aug 1, 1975, Publ by ISES, Smithsonian Rad Biol Lab, Rockville, MD, 1975

A system is described for the large scale generation of power from solar energy in which energy is transferred by means of the reversible chemical reaction  $2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2$ . A multiplicity of pressed steel paraboloidal mirrors is employed each having a focal absorber in which the endothermic forward reaction proceeds. The exothermic backward reaction occurs at a common central plant and the heat energy recovered operates a thermodynamic power plant. The reactants are transferred in small diameter steel piping at ambient temperature. Storage of energy may be catered for by providing storage for the reactants.

(THERMAL-POWER, DESIGN-REVIEW)

#### ST77 13011 COMPARISON OF SOLAR POND CONCEPTS FOR ELECTRICAL POWER GENERATION

Drumheller, K., Duffy, J.B., Harling, O.K., Knutsen, C.A., McKinnon, M.A., Peterson, P.L., Shaffer, L.H., Styris, D.L., Zaworski, R., (Battelle Pacific Northwest Labs., Richland, WA), 128 p., BNWL-1951, E(45-1)-1830, N76-33638  
 Avail:NTIS HC\$5.45

Various solar pond concepts for electric power generation were identified, including but not limited to (1) nonconvective salt gradient solar pond; (2) ponds with various plastic or other membranes at suitable locations to minimize or eliminate convection; (3) ponds which are totally or partially gelled to reduce or eliminate convection; and (4) shallow convecting ponds. The performance of these various concepts was analyzed and compared. The pond cost and overall power plant system cost for each concept assuming the nonconvective gradient salt pond as the base case were estimated. The approach included a preliminary design of several power plant systems based on solar pond concepts, and performance and economic evaluation based on these preliminary designs.

(THERMAL-POWER, ECONOMICS)

#### ST77 13012 COLLECTOR FIELD OPTIMIZATION FOR A SOLAR THERMAL ELECTRIC POWER PLANT

Easton, C.R., Raetz, J.E., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), Vant-Hull, L.L., (Houston, University, Houston, TX), New York, American Institute of Chemical Engineers, V 2:1272-1277, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12811

A procedure for optimizing a central receiver solar thermal electric power plant is presented. Key parameters of the optimization are identified and examined to show the degree of interdependence and to derive a secondary set of variables more amenable to optimization. The procedure is detailed with numerical examples, and the results for a 100-MWe commercial plant are shown.

#### ST77 13013 SOME MATERIAL CONSIDERATIONS INVOLVED IN THE APPLICATION OF SOLAR ENERGY TO ELECTRIC POWER GENERATION

Gervais, R.L., Taketani, H., Babel, H.W., Pittinato, G.F., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), Sampe Journal, V 12:12-19, Mar-Apr 1976, A77-13739

A progress report is made on two basic approaches to generating electrical power using solar energy local absorption system and central absorption system. The main difference between the two approaches is that the central absorption relies upon optical transportation of energy while the local absorption relies upon piping of thermal energy. The activities and issues associated with the formation of noncondensable gases in water heat pipes are discussed, along with some of the activities and issues for material selection and some considerations for the solar concentrator. The technical issues all appear to be resolvable with current technology. Innovative concepts, however, are required to make solar electric power competitive.

(THERMAL-POWER, COMPARISONS, ECONOMICS)

#### ST77 13014 TECHNICAL FEASIBILITY STUDY OF MODULAR DISH SOLAR ELECTRIC SYSTEMS

Gupta, B.P., Buchholz, R.L., McBride, E.M., Gray, D.C., Bohan, W.M., (Honeywell, Inc., Minneapolis, MN), NASA-CR-135012, 182 p., Mar 1976, ERDA/NASA/19740-76/1

The effort was directed at establishing the technical feasibility of modular generation of electricity through the use of dish collectors, and thereby eliminating the heat transport problem of distributed solar collector systems. The superior optical performance of dish collectors among the modular collector concepts led to its selection for detailed analysis in the power generation range of 30 to 100 kW(t) per module. Effort was also directed at the central receiver concept to examine the benefit of smaller mirror size for power generation in the range of 500 kW to 4 MW(t). On the basis of the results of the optical and thermodynamic analyses performed during this program, a paraboloid of revolution dish with a cavity receiver using an open air regenerative Brayton Cycle turbine emerged as the most promising concept in the power range from 30 to 100 kW(t) per module.

(THERMAL-POWER, COMPARISONS)



ST77 13015 CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, PHASE 1. CDRL ITEM 10. FIRST QUARTERLY TECHNICAL PROGRESS REPORT

Hallet, R.W., Jr., Gervais, R.L., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), 90 p., Jan 1976, MDC-G-6318, SAN-1108-76-1

The current definition of a 10-MWe pilot plant preliminary design base line is presented, as well as a summary of a 100 MWe commercial plant base line. The subsystems described for the plants include the collector, receiver, thermal storage, and electrical power generation. A master control concept employing a centralized computer is also described. The subsystem research experiment activities for the collector, receiver, and thermal storage subsystems are presented, including a summary of SRE test requirements, overall test scheduling, and status through the conceptual design review phase of the SRE effort.

ST77 13016 A COMPARISON OF GaAs AND Si HYBRID SOLAR POWER SYSTEMS

Heinbockel, J.H., Roberts, A.S., Jr., (Old Dominion University, Norfolk, VA), NAS1-11707-86, Princeton, NJ, Electrochemical Society, Inc., p. 170-199, 1976, In International Symposium on Solar Energy, Washington, DC, May 5-7, 1976, Proceedings, A76-47051 24-44, A76-47063

An analytical comparison of energy output from various silicon and gallium arsenide hybrid solar power systems, producing electric power and also thermal power for heating or cooling, is made. System performance indices in terms of capital cost, peak power, total power output, and electric power were evaluated. Limiting values for annual energy production from GaAs and Si solar concentrator systems were estimated to be 2 cents and 6.8 cents per kWh for GaAs concentrator systems.

(THERMAL-POWER, PHOTOVOLTAIC, ECONOMICS)

ST77 13017 WINDOWED VERSUS WINDOWLESS SOLAR ENERGY CAVITY RECEIVERS

Jarvinen, P.O., (MIT, Lexington, MA), New York, American Institute of Chemical Engineers, V 2:1244-1252, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, tute of Technology and U.S. Air Force, A77-12662 02-44, A77-12808

A model for a windowed, high-temperature cavity receiver of the heated-air type is developed and used to evaluate the greenhouse effect as a method for obtaining high receiver operating efficiencies. The effects on receiver efficiency of varying the window cutoff wavelength, the amount of absorption in the window pass-band, the cavity operating temperature, and the number of windows are determined. Single windowed cavities are found to offer theoretical efficiencies comparable to windowless ones, while multiple windowed units are found to suffer from low operating efficiencies due to losses resulting from reflections at each window/air interface. A 'first order' examination is made of the feasibility of air cooling the window to assure its survival. This appears possible if a proper combination of cooling technique and window material characteristics is selected.

(THERMAL-POWER, COMPARISONS, CENTRAL-RECEIVER)

ST77 13018 A SOLAR POWER PLANT IN THE 10 KWE RANGE WITH FOCUSING COLLECTORS

Kleinkauf, W., Koehne, R., Lindner, F., (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Energiewandlung und elektrische Antriebe, Stuttgart, West Germany), Simon, M., (Maschinenfabrik Augsburg-Nuernberg, AG, Neue Technologie, Munich, West Germany), Rome, Rassegna Internazionale Elettronica Nucleare Ed Aerospaziale, p. 541-550, 1976, In International Scientific-Technological Conference on Space, 16th, Rome, Italy, Mar 18-20, 1976, Proceedings, A76-45951 23-12, A76-45995

A 10-kWe solar power plant with focusing collectors (parabolic troughs) is described. The advantages and disadvantages of two different mountings, a simple and a more sophisticated tracking device, are discussed. The collector itself and the thermal cycle with a steam engine, storage, and an additional boiler are treated. Finally, the installation and electricity costs are presented as a function of hours of sunshine per year for the 10-kWe plant as well as larger plants.

(THERMAL-POWER, ECONOMICS, PARABOLIC-TROUGH)

ST77 13019 THERMAL STORAGE FOR SOLAR ENERGY CONVERSION

Lefrois, R.T., (Honeywell Systems and Research Center, Minneapolis, MN), Venkatesetty, H.V., (Honeywell Corporate Research Center, Bloomington, MN), Princeton, NJ, Electrochemical Society, Inc., p. 16-35, 1976, In International Symposium on Solar Energy, Washington, DC, May 5-7, 1976, Proceedings, E9(04-3)-1109, A76-47051 24-44, A76-47053

The paper describes the thermal storage subsystem for storing thermal energy by melting eutectic salts, that forms part of a central-receiver type solar thermal power pilot plant. The thermal storage unit is divided into individual cells for improved phase change performance. Each cell contains one charge cycle heat exchanger and one discharge cycle heat exchanger. Twelve main storage unit cells will generate saturated steam while another set of cells will generate superheated steam. The salt selected for the main storage is a ternary eutectic mixture of NaCl, NaNO<sub>3</sub>, and Na<sub>2</sub>SO<sub>4</sub> with eutectic temperature of 287 C and heat of fusion of 94.2 kWh(t)/Cu M.

(THERMAL-POWER, PHASE-CHANGE, CENTRAL-RECEIVER)

Lior, N., Ayyaswamy, P.S., O'Leary, J., Kauffman, K.W., Yeh, H., (Pennsylvania, University, Philadelphia, PA), Lorsch, H.G., (Franklin Institute Research Laboratories, Philadelphia, PA), New York, American Institute of Chemical Engineers, V 1:613-622, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12732

The problem of thermal energy storage for solar-thermal power generation is examined. Major conceptual systems for thermal storage are proposed and described. Storage modes through sensible heat, latent heat (phase change), and thermochemical energy are reviewed and proposed. A survey of applicable materials for thermal storage, which includes available thermophysical properties, compatibility with containing and heat transfer interfaces, and economics, is presented. The energy storage related parameters (such as temperatures, heat fluxes and quantities) of two major conceptual systems for solar-thermal power generation are identified for a power station size of 100 MWe. Mathematical details relevant to transient analyses of thermal storage have been developed and discussed.

(COMPARISONS, DESIGN-REVIEW)

## ST77 13021 PLANNING MODELS FOR THE ASSESSMENT OF ADVANCED ENERGY STORAGE SYSTEMS PH.D. THESIS

Ma, F.S.T., (Pennsylvania Univ., Philadelphia, PA), 181 p., N77-12504  
 Avail: Univ. Microfilms, Order No. 76-22731

Two alternative approaches are identified: A system storage which can be charged electrically by any conventional power plant of the system; and a solar storage which can only store non-electrical energy extracted from a renewable source (e.g., by solar thermal conversion). In both approaches, the storage is included as a limited source of energy generation in a power system. They are structured as optimal control formulations which include important basic technological parameters. The optimization problem is then solved using dynamic programming. The feasibility of a candidate configuration of each advanced technology is compared with those of advanced designs of gas turbines and combined cycles. Results of this study indicate that, based on moderately projected cost and life span estimates, the specific storage systems are more expensive than gas turbines and combined cycles.

(THERMAL-POWER, COMPUTER-MODELS, COMPARISONS)

## ST77 13022 OPTICAL SYSTEMS FOR LARGE SCALE SOLAR POWER PLANTS

McFee, R.H., (McDonnell Douglas Astronautics Co., Huntington Beach, CA), Chicago, Industrial and Scientific Conference Management, Inc., p. 100-105, 1975, In Electro-Optical Systems Design Conference and International Laser Exposition, Anaheim, CA, Nov 11-13, 1975, Proceedings of the Technical Program, A76-44926 23-35, A76-44934

An approach to the solution of some of the optical problems involved in the design of optical systems for large-scale solar power plants is presented. The computation procedure for a typical heliostat array using the element image sun approach is described. Mirror surface irregularities can be simulated by assigning slope errors to the individual elements. Receivers of different configuration may be handled by the same program through the use of a separate subroutine for each receiver design. The use of the elemental image numerical integration technique made it possible to develop a versatile and analytical tool suitable for a variety of solar power system design problems.

(THERMAL-POWER, COMPUTER MODEL)

## ST77 13023 COMING - SOLAR POWER PLANTS

Murphy, L.M., Skinrood, A.C., (Sandia Laboratories, Livermore, CA), Mechanical Engineering, V 98:26-32, Nov 1976, A77-12125

The system designs proposed by Honeywell, Martin Marietta, and McDonnell Douglas for the 10 MW(e) pilot plant and its heliostat concepts are examined. Calculations indicate that roughly 2000 heliostats, each with about 40 Sq M of reflective surface, would be required for such a plant. Annual solar energy of approximately 2.0 MWhr/Sq M of mirror area can be redirected to a receiver from a heliostat array located in a favorable location. Each of the designs examined requires approximately 100 acres of land for the 10-MW plant, but less than 40% of the land will be actually covered by mirrors. Both Honeywell and McDonnell Douglas envision a tower surrounded by a flat heliostat field. The Martin Marietta approach is to locate the tower on the southern edge of either a horizontal or sloped field. Evaluation of the different systems will not start until 1977. Preliminary studies, however, indicate that the designs proposed are workable.

(THERMAL-POWER, HELIOSTAT, ARRAY, DESIGN-REVIEW)

## ST77 13024 STEADY-STATE HEAT TRANSFER IN TRANSVERSELY HEATED POROUS MEDIA WITH APPLICATION TO FOCUSED SOLAR ENERGY COLLECTORS

Nichols, L.D., (NASA, Lewis), NASA-TN-D-8310, 46 p., Oct 1976, N76-33440/SWE

A fluid flowing in a porous medium heated transversely to the fluid flow is considered. This configuration is applicable to a focused solar energy collector for use in an electric

power generating system. A fluidized bed can be regarded as a porous medium with special properties. The solutions presented are valid for describing the effectiveness of such a fluidized bed for collecting concentrated solar energy to heat the working fluid of a heat engine. Results indicate the advantage of high thermal conductivity in the transverse direction and high operating temperature of the porous medium.

(THERMAL-POWER)

#### ST77 13025 STORAGE IN OIL OF OFF-PEAK THERMAL ENERGY FROM LARGE POWER STATIONS

Nicholson, E.W., (Exxon Enterprises, Inc., New York, NY), Cahn, R.P., (Exxon Research and Engineering Co., Linden, NJ), New York, American Institute of Chemical Engineers, V 1:598-605, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12730

A novel method of storing and recalling off-peak thermal energy from large power stations using a high-boiling refined oil as storage medium is described, and the economics of the system are developed and compared with competitive energy storage techniques. The effect of storage medium cost is analyzed, and potential methods of improving the economics of the overall system are outlined. Specific applicability to various nuclear reactor types is discussed, and other potential uses of the method are presented.

(THERMAL-POWER, ECONOMICS)

#### ST77 13026 THE ROLE OF SIMULATION IN THE DEVELOPMENT OF SOLAR-THERMAL ENERGY CONVERSION SYSTEMS

Schrenk, G.L., (Pennsylvania, University, Philadelphia, PA), New York, American Institute of Chemical Engineers, V 2:1256-1263, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12809

The design of a solar-thermal energy conversion system depends on a large number of parameters that relate to the characteristics of the solar concentrator and absorber. Only part of these parameters are amenable to experimental determination. A comprehensive balanced experimental-mathematical simulation procedure for the solar-thermal subsystem is described, and is shown to be capable of quantitative evaluation of the variables critical to the design of a realistic solar-thermal energy conversion system. A unique feature of the work discussed is the realization that we deal with an extended finite-sized source and that the resultant radiation transfer must be analyzed using cones, either infinitesimal or finite, rather than optical rays as the basic vehicle for energy transfer.

(THERMAL-POWER, MATHEMATICAL MODELS)

#### ST77 13027 THERMAL ATMOSPHERIC POWER SYSTEM CONCEPTS

Simon, D.I.M., Rome, Rassegna Internazionale Elettronica Nucleare Ed Aerospaziale, p. 525-536, 1976, In International Scientific-Technological Conference on Space, 16th, Rome, Italy, Mar 18-20, 1976, Proceedings, A76-45951 23-12, A76-45994, In German

Thermal atmospheric area power systems exploiting insolation of a roofed-over area, with the ground acting as a natural collector of sunshine energy, and a central chimney providing a convection channel for extracting energy from air currents generated, are described. Transformation of the kinetic energy of the rising air currents traversing the vertical chimney into electric power or mechanical shaft output by means of wind turbines, and utilization of random horizontal wind in addition by means of an auxiliary slewable wind turbine stage atop the vertical chimney, are also described. The concepts are recommended primary for energy-poor semi-arid regions with abundant insolation. Applications in more temperate environments are also considered.

(SEMI-ARID-REGIONS)

#### ST77 13028 KINETIC ENERGY STORAGE OF OFF-PEAK ELECTRICITY

Simpson, L.A., Oldaker, I.E., Stermscheg, J., (Atomic Energy of Canada Ltd., Pinawa, Manitoba), 72 p., Sept 1975, AECL-5116, N76-32661/OWE

The concept of using large flywheels to store off-peak electricity is considered. The development of high strength composite materials has made possible improvements in the energy storage capacity of such devices. The problems involved in designing large flywheels and their economic advantages over alternative means of energy storage are discussed. The economic arguments are based on the present or near future capabilities and costs of structural composite materials. The flywheel costs turn out to be considerably higher than for many alternative schemes including advanced batteries, gas turbine generators, and pumped storage schemes.

(FLYWHEEL STORAGE, ECONOMICS)

#### ST77 13029 SOLAR IS PRACTICAL

Smith, O.J.M., (Univ. of California, Berkeley, CA), 3 p.  
Avail:Univ. of California, Berkeley, CA

Solar power plants can be built immediately to reduce our dependence on imported energy, to provide needed employment, and to save depletable resources. They can be built using conventional engineering techniques and conventional materials. The design can be versatile with alternatives available for almost every component. The plant can be built so that it is easy to retrofit it in the future to change to improved or lower cost mirrors, to change to improved heat-exchange fluids, and to install additional heat storage and the associated additional mirror fields.

(SOLAR-OVERVIEW, CONVERSION-POTENTIALS, THERMAL-POWER)

ST77 13030 MULTIMODULE PRACTICAL SOLAR-THERMAL-ELECTRICAL POWER PLANTS

Smith, O.J.M., (Univ. of California, Berkley, CA), Energy Economics Environment Engineering, Proceedings, Frontiers of Power Technology, Oct 27-28, 1976  
Avail: Oklahoma State University Extension College of Engineering

A practical solar-thermal-electric power plant can be built at a reasonable cost with available technology and materials. This paper reviews the design and construction of a proposed power generation system to produce 100 megawatts.

(THERMAL-POWER, CONCENTRATOR, DESIGN-REVIEW)

ST77 13031 DESIGN CONSIDERATIONS FOR SMITH STRIP-MIRROR SOLAR-ELECTRIC PLANT

Smith, O.J.M., (Univ. of California, Berkeley, CA), 34 p.  
Avail: Univ. of California, Berkeley, CA

A practical solar-thermal-electric power plant can be built at a reasonable cost with available materials and conventional engineering design techniques. Fields of adjustable strip-mirrors concentrate the reflected sunlight on hot receptor strips behind heat-conserving windows on short towers. The absorbed heat from the hot receptors is carried by heat exchange fluids through pipes to a central station power plant containing heat exchangers to preheat and boil water and to superheat steam, and a conventional turbine and electrical generator.

(THERMAL-POWER, ECONOMICS)

ST77 13032 CENTRAL STATION SOLAR ELECTRIC POWER USING LIQUID METAL HEAT TRANSPORT

Springer, T.H., Thomson, W.B., (Rockwell International Corp., Atomics International Div., Canoga Park, CA), New York, American Institute of Chemical Engineers, V 2:1232-1238, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, Proceedings, A77-12662 02-44, A77-12806

A study has been made of a 100 MWe solar thermal electric power station using the tower concept in which liquid sodium is used to transport heat from the receiver on the tower to steam generators on the ground. The advantages of using sodium are (1) the ability to accept a severe heat flux at the receiver, (2) a dense, single-phase coolant with no inherent flow instabilities, (3) an inherently low receiver coolant pressure, (4) sodium reheat can be used in the cycle, and (5) sodium technology has advanced sufficiently to be successfully applied in such a power station. Conceptual design data for the mirror system, receiver, sodium heat transport system, steam system, and heat rejection system are presented. Thermal storage is discussed. Data on the present state of liquid sodium technology are given.

(THERMAL-POWER, CENTRAL-TOWER)

ST77 13033 A SOLAR THERMAL ELECTRIC POWER OVERVIEW

Stromberg, R.P., (Sandia Laboratories, Albuquerque, NM), New York, Institute of Electrical and Electronics Engineers, Inc., p. 74-75, 1976, In Engineering in a Changing Economy; Proceedings of the Southeast Region 3 Conference, Clemson, SC, Apr 5-7, 1976, A76-47201 24-99, A76-47207

An aggressive program to establish the feasibility of solar energy for producing electricity is being sponsored by the Energy Research and Development Administration (ERDA). Two major ideas are being pursued. Central power plants, remotely located, would replace conventionally fueled plants. Total energy systems, closer to the developed areas of cities, would produce electricity and utilize the large amounts of thermal energy otherwise lost. Economies of solar energy systems look marginal in contrast to current fuel prices. It will be necessary to change incentives in order to accelerate the transfer from fossil fuels to alternate sources of energy.

(COMPARISONS, ECONOMICS)

ST77 13034 ECONOMIC OPTIMIZATION OF THE ENERGY TRANSPORT COMPONENT OF A LARGE DISTRIBUTED SOLAR POWER PLANT

Turner, R.H., (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), New York, American Institute of Chemical Engineers, V 2:1239-1243, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, Volume 2, A77-12662 02-44, A77-12807

A solar thermal power plant with a field of collectors, each locally heating some transport fluid, requires a pipe network system for eventual delivery of energy power generation equipment. For a given collector distribution and pipe network geometry, a technique is herein developed which manipulates basic cost information and physical data in order to design an energy transport system consistent with minimized cost constrained by a calculated technical performance. For a given transport fluid and collector conditions, the method determines the network pipe diameter and pipe thickness distribution and also insulation thickness distribution associated with minimum system cost; these relative distributions are unique. Transport losses, including pump work and heat leak, are calculated operating expenses and impact the total system cost. The minimum cost system is readily selected. The technique is demonstrated on six candidate transport fluids to emphasize which parameters dominate the system cost and to provide basic decision data. Three different power plant output sizes are evaluated in each case to determine severity of diseconomy of scale.

(THERMAL-POWER, MATHEMATICAL MODELS)

ST77 13035 THERMAL ENERGY STORAGE MATERIAL THERMOPHYSICAL PROPERTY MEASUREMENT AND HEAT TRANSFER IMPACT

Tye, R.P., Bourne, J.G., Destarlais, A.O., (Dynatech R/D Co., Cambridge, MA), NASA-CR-135098, NAS3-19716, 98 p., REPT-1503, N77-12510  
Avail:NTIS

The thermophysical properties of salts having potential for thermal energy storage to provide peaking energy in conventional electric utility power plants were investigated. The power plants studied were the pressurized water reactor, boiling water reactor, supercritical steam reactor, and high temperature gas reactor. The salts considered were  $\text{LiNO}_3$ ,  $63\text{LiOH}/37\text{LiCl}$  eutectic,  $\text{LiOH}$ , and  $\text{Na}_2\text{B}_4\text{O}_7$ . The thermal conductivity, specific heat (including latent heat of fusion), and density of each salt were measured for a temperature range of at least  $\pm$  or  $-$  100 K of the measured melting point. Measurements were made with both reagent and commercial grades of each salt.

(THERMAL-POWER, PHASE-CHANGE)

ST77 13036 THERMODYNAMIC ANALYSIS AND SELECTION OF OPTIMAL PARAMETERS OF A DYNAMIC CONVERTER FOR A SOLAR ENERGY SET-UP - UTILIZING STIRLING ENGINE

Umarov, G.Ia., Orunov, B.B., Kliuchevskii, Iu.E., Tursunbaev, I.A., Trukhov, V.S., (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR), Geliotekhnika, p. 31-34, N5, 1976, A77-14580, In Russian  
No Abstract Available

(THERMAL-POWER)

ST77 13037 THERMAL ENERGY STORAGE FOR SOLAR POWER PLANTS

Venkatesetty, H.V., Lefrois, R.T., (Honeywell, Inc., Minneapolis, MN), New York, American Institute of Chemical Engineers, V 1:606-612, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12731

Experimental techniques and results obtained for a number of promising phase-change materials for the thermal energy storage subsystem of central receiver solar thermal power pilot plant are presented. Nine inorganic eutectic compositions with melting points between 220 and 290 C were studied with two of them;  $\text{NaNH}_2\text{O}_3\text{-NaOH}$  and  $\text{NaCl-NaNO}_3\text{-Na}_2\text{SO}_4$ , chosen for further investigation. The thermal stability and phase characteristics of the latter eutectic were examined as were the effects of thermal cycling on the stability and heats of fusion of both eutectics. Engineering model experimentation results associated with latent heat storage dynamic processes are also described with attention given to vaporizer heat transfer, and solid salt removal and settling.

(PHASE-CHANGE, OVERVIEW)

ST77 13038 CALORIMETRY OF LARGE SOLAR CONCENTRATORS

Waddington, D., (Martin Marietta Aerospace, Denver, CO), New York, American Institute of Chemical Engineers, V 2:1291-1295, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12884

The development of large focusing heliostats to concentrate solar energy on a boiler or central receiver demands a method of measuring the concentration efficiency. A flat plate calorimeter, using the temperature rise in water at a measured flow rate, has been employed to test a 22.3-square-meter heliostat focused at a distance of 31 meters. These measurements represent the first tests of large-area concentrating heliostats in this country. This paper presents the calorimeter design, defining absorptance of the flat plate coating, the instrumentation, and the capabilities for calibration and error correction. Typical tests are discussed and data are included. Evaluation data taken with an AGA thermovision infrared scanner confirm flux distribution on the calorimeter receiver plate. The prototype calorimeter has successfully measured solar fluxes of 47,307 W/Sq M and total fluxes of 14,650 watts.

(THERMAL-POWER, INSTRUMENTS)

Wen, L., Wu, Y.C., (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), New York, American Institute of Chemical Engineers, V 2:1209-1215, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12803

A performance comparison is made between the central receiver system (power tower) and a distributed system using either dishes or troughs and lines to transport fluids to the power station. These systems were analyzed at a rated capacity of 30 MW of thermal energy delivered in the form of superheated steam at 538 C (1000 F) and 68 ATM (1000 PSIA), using consistent weather data, collector surface waviness, pointing error, and electric conversion efficiency. The comparisons include technical considerations for component requirements, land utilization, and annual thermal energy collection rates. The relative merits of different representative systems are dependent upon the overall conversion as expressed in the form of performance factors in this paper. These factors are essentially indices of the relative performance effectiveness for different concepts based upon unit collector area. These performance factors enable further economic tradeoff studies of systems to be made by comparing them with projected production costs for these systems.

(ECONOMICS)

#### ST77 13040 THE IMPACT OF TES ON ENERGY STRUCTURES - THERMAL ENERGY STORAGE

Wilson, J.E., (Ontario Hydro, Energy and Environmental Studies Dept., Toronto, Canada), Glendenning, I., (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England), Bourgeois, B., (CNRS, Institut Economique Et Juridique De L'Energie, Grenoble, France), Fells, I., (Newcastle-Upon-Tyne, University, Newcastle-Upon-Tyne, England), Glenn, D.R., (GE Valley Forge Space Center, Philadelphia, PA), Golibersuch, D., (GE Research and Development Center, Schenectady, NY), Hannes, K., (Steag-Anlagentechnik, Essen, West Germany), Hoerster, H., (Philipps Forschungslaboratorium Aachen GMBH, Aachen, West Germany), Knobbout, J.A., (Central Organisatie Voor Toegepast-Natuurwetenschappelijk Onderzoek, Apeldoorn, Netherlands), Lowe, P.A., (ERDA, Thermal Energy Storage Branch, Washington, DC), p. 49-72, 1976, In Thermal Energy Storage; NATO Science Committee Conference, Turnberry, Scotland, Mar 1-5, 1976, Report, Brussels, NATO, A76-45543 23-44, A76-45548

Thermal energy storage for residential and commercial energy structures (space heating, water heating, process heat, seasonal storage, etc.) is considered. Some industrial groupings (cement, iron and steel, food, paper, aluminum, batch/variable processes, etc.) considered possible for TES applications are examined. TES is also discussed in relation to urban heating systems (e.g., district heating), energy transport and transportation, and electric utilities.

(THERMAL-POWER, TOTAL-ENERGY-SYSTEMS, OVERVIEW)

## 14,000 THERMIONIC/THERMOELECTRIC

#### ST77 14000 PROGRAM OF THERMOELECTRIC GENERATOR TESTING AND RTG DEGRADATION MECHANISMS EVALUATION. PROGRESS REPORT NO. 17

(Jet Propulsion Lab., Pasadena, CA), 83 p., July 1976, JPL-7

Research progress is reported on silicon germanium technology including (1) silicon nitride coating experiments (long-term vacuum experiments for Si sub 3 N sub 4 -coated hot shoes and CO environment tests of Si sub 3 N sub 4 -coated hot shoes); (2) vacuum conductance experiments; (3) MHW-RTG degradation code (DEGRA); (4) 4-couple module experiments; and (5) thermoelectric property characteristics. Selenide material evaluation tests included (1) thermal conductivity tests; (2) in-gradient tests; and (3) isothermal experiment. Thermoelectric generator tests and evaluation included (1) high performance generator, HPG SN-2; (2) transit generator, QM III (subgenerator G sub 1, subgenerator G sub 2, and subgenerator G sub 3); (3) ring converter; (4) MHW-TBC-1; and (5) RCA reference generator.

(OVERVIEWS)

#### ST77 14001 ADVANCED THERMIONIC ENERGY CONVERSION

Britt, E.J., Fitzpatrick, G.D., Hansen, L.K., Rasor, N.S., (Rasor Associates, Inc., Sunnyvale, CA), NASA-CR-148569, 136 p., 1974, COD-2263-2, N76-28989/1WE, PCS10.00/MFS3.00

Basic analytical and experimental exploration was conducted on several types of advanced thermionic energy converters, and preliminary analysis was performed on systems utilizing advanced converter performance. The Pt-Nb cylindrical diode which exhibited a suppressed arc drop, as described in the preceding report, was reassembled and the existence of the postulated hybrid mode of operation was tentatively confirmed. Initial data obtained on ignited and unignited triode operation in the demountable cesium vapor system essentially confirmed the design principles developed in earlier work, with a few exceptions. Three specific advanced converter concepts were selected as candidates for concentrated basic study and for practical

evaluation in fixed-configuration converters. Test vehicles and test stands for these converters and a unique controlled-atmosphere station for converter assembly and processing were designed, and procurement was initiated.

(COMPARISONS, TEST-DATA)

#### ST77 14002 DIMINIODE THERMIONIC CONVERSION WITH 111-IRIDIUM ELECTRODES

Koeger, E.W., Bair, V.L., Morris, J.F., (NASA, Lewis), NASA-TM-X-73492, 11 p., Sept 1976, E-8888, N76-33991/OWE

Preliminary data indicating thermionic-conversion potentialities for a 111-iridium emitter and collector spaced 0.2 mm apart are presented. These results comprise output densities of current and of power as functions of voltage for three sets of emitter, collector, and reservoir temperatures: 1553, 944, 561 K; 1605, 898, 533 K; and 1656, 1028, 586 K. For the 1605 K evaluation, estimates produced work-function values of 2.22 eV for the emitter and 1.63 eV for the collector with a 2.0-eV barrier index (collector work function plus interelectrode voltage drop) corresponding to the maximum output of 5.5 W/sq cm at 0.24 volt. The current, voltage curve for the 1656 K 111-iridium diminiode yields a 6.2 W/sq cm maximum at 0.25 volt and is comparable with the 1700 K envelope for a diode with an etched-rhenium emitter and a 0.025-mm electrode gap made by TECO and evaluated by NASA.

(DESIGN-REVIEW)

#### ST77 14003 THERMIONIC ENERGY CONVERSION RESEARCH ANALYSIS. ANNUAL PROGRESS REPORT

Lam, S.H., (Princeton Univ., NJ), 14 p., 1976, COO-2533-4

This progress report summarizes the major results presented in "Preliminary Report on Plasma Arc-Drop in Thermionic Energy Converters," (COO-2533-4), and includes additional discussions on the magnitude of the normalized plasma resistance required to achieve low arc-drop converter operation.

#### ST77 14004 THERMOELECTRIC MODULE DESIGNED FOR A WIDE RANGE OF APPLICATIONS USING HIGH PERFORMANCE SELENIDE MATERIALS

Reylek, R.S., Hampl, E.F., Jr., Hinderman, J.D., Smith, R.L., Wald, D.A., (3 M Pioneering Laboratory, St. Paul, MN), New York, American Institute of Chemical Engineers, V 2:1599-1605, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12856

High performance selenide thermoelectric materials offer significant potential for performance improvement of thermoelectric generators. The use of these materials in generator designs has been previously reported. This paper describes thermoelectric modules (typically 25 W(e) output) of advanced design which will be compatible with a wide range of generator concepts, including rectangular and cylindrical configurations. The module design is described and the effect of operating temperatures and other design conditions on the particulars of the design are discussed. The basic module consists of several components which promote high efficiency, low weight, and long life. Test results on these components are described which verify design assumptions.

(DESIGN-REVIEW)

### 15,000 OCEAN THERMAL DIFFERENTIAL

#### ST77 15000 OCEAN THERMAL ENERGY CONVERSION (OTEC)

(ERDA, Washington, DC), 97 p., OTEC Program Summary, Oct 1976, ERDA76-142

Ocean Thermal Energy Conversion (OTEC) is one of six solar technologies that constituted the original U.S. solar energy program. Those technologies were selected by the National Science Foundation (NSF) Research Applied to National Needs (RANN) program as being options that could each potentially provide a substantial energy contribution to the nation. When the U.S. Energy Research and Development Administration (ERDA) was established on January 19, 1975, the lead role in solar energy was transferred from NSF to ERDA.

(OCEAN AT, UNITED-STATES, OVERVIEW)

#### ST77 15001 FEASIBILITY STUDY OF A HIGH-SPEED OCEAN THERMAL ENGINE

Abom, J., (Chalmers Univ of Technol, Goteborg, Sweden), Mar Technol Soc J, V 9:11-18, N8, 6 refs, Sept 1976

Research has shown that one can obtain a net work output of about 20 kpm per liter of water which is passed through an experimental engine when the temperature difference between the cold and warm water is 25°C. With an industrially developed engine one can obtain,

supposedly, about 30 kpm per liter of water. It is possible that those developing countries, which have access to warm surface water and cold bottom water, can use this engine in the future to fill in their increasing power needs on the basis of the fact that one can almost obtain a Carnot-process which gives the maximum thermal conversion efficiency at given temperature levels.

(OCEAN AT, OVERVIEW)

ST77 15002 MARINE FOULING OF TITANIUM HEAT EXCHANGERS

Adamson, W.L., (Naval Ship Research and Development Center, Annapolis, MD), 30 p., AD-A022207 PAS-75-29, N76-33458  
Avail:NTIS

A series of marine fouling experiments was conducted at Freeport, Texas, on two single-pass titanium heat exchangers. The exchangers, which were constructed with commercially pure titanium tubes (5/8-inch (1.59-centimeter)) outside diameter by 30-inch (76.3-centimeter length) and 6Al-4V alloy tube sheets and headers, were operated on natural seawater. One of the exchangers was fed electrolytically chlorinated seawater, while the other was run with untreated seawater feed. Velocity and chlorination levels were varied to determine the effect of these two variables on fouling of the titanium surfaces. Operating conditions similar to those that might be expected in shipboard heat exchanger/condenser usage were modeled.

(OCEAN AT, TEST DATA, MODELS)

ST77 15003 OCEAN THERMAL ENERGY CONVERSION: RESOURCE ASSESSMENT AND ENVIRONMENTAL IMPACT FOR PROPOSED PUERTO RICO SITE

Atwood, D., Duncan, P., Stalcup, M.C., Barcelona, M.J., (Puerto Rico Univ., Mayaguez, Puerto Rico), NSF/RA-760249, 107 p., Aug 1976, PB-259 303/6WE

This report centers on the possibility of extracting thermal energy stored in the tropical sea surface by Ocean Thermal Energy Conversion (OTEC) at a site near the town of Yabucoa, on the southeast coast of Puerto Rico. The report consists of two parts. Part I is a survey of existing oceanographic and meteorological data at and near the site and for other possible sites near Puerto Rico. Part II is a survey of the specific site to confirm the oceanographic conditions prevalent there.

(OCEAN AT, DATA-SURVEY, SITING)

ST77 15004 MARITIME AND CONSTRUCTION ASPECTS OF OCEAN THERMAL ENERGY CONVERSION (OTEC) PLANT SHIPS

Avery, W.H., Blevins, R.W., Dugger, G.L., Francis, E.J., (Applied Physics Lab., Johns Hopkins Univ., Laurel, MD), 41 p., Sponsored by Maritime Admin., APL/JHU-SR-76-1A MA/RD-940-T76065, PB-255639/7, N77-12552  
Avail:NTIS

An analysis of the maritime, construction, and cost aspects of Ocean Thermal Energy Conversion (OTEC) plant ships for deployment in tropical oceans to produce ammonia and other energy intensive products is given. A concept was developed for OTEC plant ships for use at selected sites in tropical oceans to produce energy intensive products on board. These platforms are very stable under normal operating conditions and serve many other needs.

(OCEAN AT, ECONOMICS)

ST77 15005 CONCURRENT STUDIES OF ENHANCED HEAT TRANSFER AND MATERIALS FOR OCEAN THERMAL EXCHANGERS

Bonewitz, R.A., (Aluminum Co. of America, Alcoa Laboratories, Chemical Metallurgy Div., Alcoa Center, PA), 69 p., Final Report Oct 29, 1976, (Contract No. E(11-1)-2641), (Carnegie Mellon/Alcoa Subcontract No. 1-53500), for ERDA

Aluminum alloys 1100, 3003, 5052, and 6063 were examined for their compatibility with the proposed working fluids for Ocean Thermal Energy Conversion (OTEC), anhydrous ammonia, Freon 22 and propane, and mixtures of these with sea water. Such mixtures would occur if leaks develop in evaporator or condenser heat exchangers. These aluminum alloys are compatible with the anhydrous working fluids. In ammonia-sea water solutions only limited general corrosion is found in 0-30% ammonia, no corrosion in 30-90% ammonia, and "self limiting" pits in 90-100% ammonia so rapid deterioration of the exchangers would not occur. No corrosion was observed in sea water saturated with Freon 22 or propane. No differences in alloy performance were evident in any of these tests so selection can be made on the basis of compatibility with sea water. A review of the available literature indicates that 5052 shows the best performance in surface sea water followed by 1100, 3003, and then 6063 alloy. In deep sea water only 5052 and 1100 alloys appear suitable although more data is required. In both surface and deep sea waters, alcladding offers the best protection against tube perforation; few instances of penetration into the core alloy have been observed for the alclad alloys examined in this study.

(OCEAN AT, FLUIDS-WORKING)



ST77 15006 AN INVESTIGATION OF HEAT EXCHANGERS FOR OCEAN THERMAL ENERGY CONVERSION (OTEC) SYSTEMS

Braren, R., McGowan, J.G., (Massachusetts Univ., Amherst, MA), NSF/RANN/SE/GI-34979/TR/75/8 NSF/RA/N-75-236 NSF GI-34979, 140 p., PB-252640/8, N77-10668  
 Avail:NTIS

Analytical results for the design of evaporators and condensers for Ocean Thermal Energy Conversion (OTEC) systems are presented. The generalized digital computer program for OTEC thermal cycle analysis was used for several parametric studies. These included the investigation of (1) power plant size, (2) heat exchanger materials, (3) plastic plate-fin exchangers, (4) siting choice, (5) tube bank evaporators, (6) fouling effects, and (7) evaporator recirculation. Models are developed for evaluation of the steady-state off-design performance of both the evaporator and condenser, and an initial off-design study is made of a particular system design.

(OCEAN AT, COMPUTER PROGRAMS, DESIGN-OVERVIEWS)

ST77 15007 AN OPTIMIZATION STUDY OF A LOW THERMAL POTENTIAL POWER SYSTEM

Buckingham, J.R., Raikes, W.M., Kelleher, M.D., (Naval Postgraduate School, Monterey, CA), 111 p., Sept 1976, NPS-69Kk76091, AD-A031 709/9WE

A power generating system using the low thermal potential available from the vertical temperature distribution of the ocean is analyzed as a combined engineering and economic mathematical model. The model is optimized for minimum capital cost employing a sequential unconstrained minimization algorithm. Examples of the kinds of engineering and cost information available from the model are presented.

(OCEAN AT, MATHEMATICAL MODEL, ECONOMICS)

ST77 15008 AN ANALYTICAL STUDY OF THE IRREVERSIBLE LOSSES ASSOCIATED WITH VAPOR FLOW IN EVAPORATOR OF SOLAR SEA POWER PLANT - MANIFOLD PROBLEM

Farthing, G.A., Jr., (Carnegie Mellon Univ., Pittsburgh, PA), Report No. ERDA/SE/E(11-1)2895/TR/76/2, 144 p., Apr 1976, (Grant No. ERDA E(11-1)2895), Sponsored by ERDA, Washington, DC

The irreversible losses associated with the flow of vapor in the evaporator of a Solar Sea Power Plant are investigated analytically. Fundamentally, a two-dimensional analysis using both the momentum equation and the Bernoulli equation is shown to be the most realistic approach to the solution of the outlet manifold problem. Using these ideal fluid solutions as a basis, two outlet manifold models are developed which are directly applicable to the flow of vapor in the evaporator of a Solar Sea Power Plant. A large number of charts - contained in the appendices - are generated using the two models. Through the use of the models, it is shown that, while the flow losses in the evaporator are not negligible, they are not seen as a serious threat to the feasibility of a Solar Sea Power Plant, either.

(OCEAN AT, HEAT-EXCHANGERS, MATHEMATICAL MODELS)

ST77 15009 CONCRETE FOR OCEAN THERMAL ENERGY, CONVERSION STRUCTURES

Haynes, H.H., Rail, R.D., (Civil Engineering Lab, Navy, Port Hueneme, CA), 50 p., Aug 1976, CEL-TN-1448, AD-A031 045/8WE

The purpose of this study was to assess the state of the art of concrete technology and construction practices as they are related to the construction of massive floating structures to house ocean thermal energy conversion (OTEC) systems. The relevant capabilities and limitations of available concrete technology and construction practices are described and deficient areas identified. Recommendations for research and development are given by which reasonable improvements can be made in the near term to provide greater assurances of long-term safe and reliable operation of the OTEC systems and to provide lower cost structures.

(OCEAN AT, ECONOMICS)

ST77 15010 DYNAMIC MODELING AND CONTROL OF SOLAR SEA POWER PLANTS, PART 1

Hetyei, S.A., Neuman, C.P., (Carnegie-Mellon Univ., Pittsburgh, PA), NSF/RANN/SE/GI-39114/PR-75-7, NSF/RA/N-75-270, NSF AER-73-07863-A02, NSF GI-39114, 144 p., PB-252983/2, N76-32692  
 Avail:NTIS HC\$5.50

A methodology is developed for modeling the dynamic behavior of solar sea power plant (SSPP) condensers and evaporators. Because of the complexity of a solar sea power plant, dynamic modeling is an essential step prior to the design and construction of a prototype plant. The pertinent physical laws of heat transfer and mass balance are applied to develop lumped parameter, dynamic and steady-state models for single tube condensers and evaporator pre-heaters incorporating falling films. The condenser and pre-heater models are each specified by three ordinary differential equations and one, and two, algebraic equations with time-delay, respectively.

(OCEAN AT, MATHEMATICAL MODELS)

ST77 15011 PRELIMINARY RESEARCH ON OCEAN ENERGY INDUSTRIAL COMPLEXES

Hornburg, C.D., Lindal, B., El-Ramly, N., (DSS Engineers, Inc., Fort Lauderdale, FL), 24 p., 1976, CONF-760821-2

Results of a one year study on the feasibility of producing energy intensive products at ocean sites using electricity generated from Ocean Thermal Energy Conversion (OTEC) plants are presented. Analysis of production methods and other data on 62 major products lead to selecting 23 of these for further study. Production was grouped into five separate, possible complexes. Further market and transportation studies showed that production of products in a sea chemicals complex and an organic chemicals and plastics complex had the highest economic potential. Detailed designs of these two complexes are presented. The three potential sites were selected for these OTECs. An environmental assessment revealed that these complexes would have no adverse environmental impact. The selected products can be produced at ocean sites competitively with production at similar land-based complexes. Return on investment will be between 13 and 18 percent depending on actual power costs and details of the final designs.

(OCEAN AT, ONSITE-PRODUCTION, ECONOMICS, DESIGN-REVIEW, ENVIRONMENT)

ST77 15012 ENERGY TRANSMISSION FROM OCEAN THERMAL ENERGY CONVERSION PLANTS

Konopka, A., Talib, A., Yudow, B., Biederman, N., (Institute of Gas Technology, Chicago, IL), 10 p., 1976, CONF-760906-20

This paper compares the transmission, by barge and pipeline, of gaseous hydrogen, liquid hydrogen, and ammonia, as energy carriers, with transmission of electricity in submarine cables from an OTEC plant. Because hydrogen energy and electrical energy are not equivalent, comparison requires assuming the outputs are converted to a common form. Thus, the authors present the delivered cost and overall energy efficiency of hydrogen, ammonia, and electricity as well as a discussion of the equipment, costs and efficiencies of converting hydrogen and ammonia into electricity, and OTEC mechanical energy into hydrogen and ammonia. Converting electricity to chemical commodities and energies was not assessed.

(OCEAN AT, ENERGY-CARRIERS)

ST77 15013 ECONOMIC EVALUATION OF MIXTURE AND PURE FLUID CYCLES IN OCEAN THERMAL ENERGY CONVERSION SYSTEMS

Lawson, C.A., (Oklahoma Univ., Norman, OK), 144 p., Apr 30, 1976, ORO-4918-8

The OTEC3-1 simulator is capable of calculating the capital cost of major equipment in an Ocean Thermal Energy Conversion power plant. The results of this research study indicate that the heat exchangers are the principal contributors to the capital cost of the ocean thermal power plant. The sensitivity analysis performed in this research study showed that there are several economic trade-offs associated with the design and performance of the heat exchanger. The trade-offs include such items as the cold water pipe length, the sea water temperature rise and velocity. It was observed that mixtures provide an increasing economic advantage over pure fluids as the temperature rise in the cold sea water is increased. It is postulated that significant economic savings can be experienced with the use of mixtures if the cost of the heat exchanger can be reduced by one-half their present cost.

(OCEAN AT, TRADE-OFFS)

ST77 15014 DEEP WATER PIPE AND MOORING DESIGN STUDY OCEAN THERMAL ENERGY CONVERSION PROGRAM. FIRST QUARTERLY PROGRESS REPORT, MAY 1, 1975-AUGUST 1, 1975

Little, T.E., (Westinghouse Electric Corp., Annapolis, MD), 25 p., Aug 14, 1975, TID-27037

The Westinghouse Oceanic Division is participating in the study of ocean engineering issues affecting the design, construction, deployment, and operation of Ocean Thermal Energy Conversion (OTEC) power plants. Specifically this study responds to the problems of conceptual design, analysis, and evaluation of three major subsystems; (1) cold water piping, (2) cold water pumping, and (3) platform mooring arrangement. This first quarterly report provides a summary of the study objectives and the highlights of the progress against these objectives. The study strategy is reviewed, a project milestone schedule is presented, and a general plan of work is described.

(OCEAN AT, PUMPING)

ST77 15015 ANALYTICAL STUDY OF TWO-PHASE-FLOW HEAT EXCHANGERS FOR OTEC SYSTEMS

Olsen, H.L., Pandolfini, P.P., (Johns Hopkins Univ., Laurel, MD), 133 p., July 1, 1975, AFL/JHU/AEO-75-37

The work began in July 1975. Prior in-house research at the Laboratory had spanned two years and had yielded a preliminary design for a low-cost OTEC plant-ship intended for operation in tropical oceans for producing ammonia or other energy-intensive products. Because the heat exchanger concept represented an extrapolation from existing experience, a comprehensive analytical study followed by an essentially full-scale experiment with the basic heat exchanger elements is needed. The analytical study reported herein is believed to meet the first requirement, and a plan for the experiment is included.

(OCEAN AT)

ST77 15016 OCEAN THERMAL ENERGY CONVERSION OPPORTUNITIES

Perrigo, L.D., Jensen, G.A., (Battelle Pacific Northwest Labs., Richland, WA), 31 p., May 1976, CONF-760549-1, BNWL-SA-5808

Ocean Thermal Energy Conversion is one of several different concepts for use of solar energy. Recent estimates suggest about 4 percent of our nation's energy needs in 2020 might be supplied by successful use of this concept which involves the operation of a heat engine on the temperature difference between surface and deeper ocean waters in the tropics. However, to achieve the base load power potential of this process a substantial research and development effort is needed in the next few decades. Major improvements are required for control of bio-fouling and corrosion and improved heat transfer systems. The thermodynamic efficiencies of this process are very low and methods for preventing film deposits are mandatory. Heat transfer cannot realistically be improved by increasing pump rates or heat transfer surfaces because of intolerable parasitic power demands or capital expenditures. The development and use of OTEC power plants also has political implications that must be accommodated. Operation of such systems must be reconciled with various international agreements, the needs of marine navigation, and national defense requirements.

(OCEAN AT, OVERVIEWS, SOCIO-POLITICAL)

ST77 15017 OCEAN ENERGY SYSTEMS: NATIONAL NEEDS AND CAPABILITIES

Richards, A.F., (Lehigh Univ, Bethlehem, PA), Background Pap on Seafloor Eng: Natl Needs in Seafloor Eng, V 1:131-205, 89 refs, Prep for Natl Res Council, Comm on Seafloor Eng, Washington, DC, 1975

Eight methods, plus a number of variants, for obtaining energy from the oceans are presented in decreasing order of potential importance: ocean thermal; kelp bioconversion; waves; tides and tidal currents; winds; ocean currents; salinity gradients; and geothermal. Each is discussed in terms of concepts, applicable geographic areas, development schedule and costs, and seafloor interaction. None of these methods yields "excess" heat into the environment, as do fossil fuel and nuclear power generating plants. It is concluded that ocean thermal, kelp bioconversion, and wave methods at present appear to have the greatest economic and technological merit.

(OCEAN AT, BIOMASS, WIND, TIDAL, COMPARISONS, ENVIRONMENT)

ST77 15018 CONCURRENT STUDIES OF ENHANCED HEAT TRANSFER AND MATERIALS FOR OCEAN THERMAL EXCHANGERS

Rothfus, R.R., (Carnegie-Mellon Univ., Pittsburgh, PA), Report No. COO/2641-1, 45 p., July 31, 1976, (Contract/Grant No. EY-76-S-02-2641), Sponsored by ERDA, Washington, DC

To demonstrate the enhancement of heat transfer in OTEC exchangers by means of fine, axial flutes on the heat transfer surfaces, experiments have been performed on single internally or externally fluted tubes of 1-inch diameter. Internal flutes provide water-side enhancement of both heat transfer and friction to about the same extent. Heat transfer experiments have been performed on Freon-11 moving in a thin layer under gravity down the outer surface of a smooth tube and of a tube having 26-mil external, axial flutes. Work is continuing in order to establish the separate effects of flute style and size on the water side and to extend the findings to ammonia on the power-fluid side of the heat transfer surface.

(OCEAN AT, FLUIDS-WORKING)

ST77 15019 DESIGN AND MODELING OF SOLAR SEA POWER PLANTS BY GEOMETRIC PROGRAMMING PH.D THESIS

Wu, C.C., (Carnegie-Mellon Univ., Pittsburgh, PA), 159 p., ERDA/SE/E(11-1)2895/TR/76/1, Order No. 76-19981, N77-14582  
 Avail: Univ. Microfilms

Geometric programming, a nonlinear optimization technique, is used to design solar sea power plants (SSPP) which convert the thermal energy stored in the tropical water into electricity. First, the conversion process is described, and the hardware necessary to implement a binary-fluid, closed-Rankine cycle is identified. Next, steady-state analytical models for the major components are derived. These models are then used as the constraints of a geometric program whose objective function is the minimization of a particular function of the design variables of the SSPP. A variety of problems are solved. The geometric programming technique produces the optimum design and, more importantly, the sensitivity of the objective function at the optimum to variations in cost figures, constraint bounds, and arbitrary constants of the model.

(OCEAN AT, COMPUTER MODEL, OPTIMIZATION)

ST77 16000 INVESTIGATION OF THE FEASIBILITY OF USING WINDPOWER FOR SPACE HEATING IN COLDER CLIMATES. THIRD QUARTERLY PROGRESS REPORT COVERING THE FINAL DESIGN AND MANUFACTURING PHASE OF THE PROJECT, SEPTEMBER TO DECEMBER 1975

(Massachusetts Univ., Amherst, MA), 165 p., Dec 1975, ERDA/NSF/00603-75/T1

Progress during the third quarter has been inadequate. The overall project is now 4 weeks behind schedule, which means that data collection at Solar Habitat One will not begin until mid March 1976, the twelfth month of this phase of the work. System design and cost analysis are summarized.

ST77 16001 ENERGY-STORAGE REQUIREMENTS REDUCED IN COUPLED WIND-SOLAR GENERATING SYSTEMS

Andrews, J.W., (Southampton College of Long Island University, Southampton, NY), Solar Energy, V 18:73-74, 8 refs, 1976

The development of the sun and the winds as useful sources of power has been hampered by the variability and, over short periods of time, the unpredictability of the power which can be drawn from them. The resulting need to provide either backup generating capacity or some form of reservoir for storing energy has contributed to the belief, generally held almost without question until recently, that while potentially able to supply vast amounts of energy, they are inherently uneconomical.

ST77 16002 APPLICATION STUDY OF WIND POWER TECHNOLOGY TO THE CITY OF HART, MICHIGAN

Asmussen, J., Fisher, P.D., Park, G.L., Krauss, O., (Michigan State Univ., East Lansing, MI), 103 p., Dec 31, 1975, COO-2603-1, PC\$5.50/MF\$3.00

Information is presented concerning wind data collections and analysis; Hart power demand and consumer usage; wind power assessment; hydro power assessment; results of preliminary economics analysis; environmental impact of wind turbines and operation in the Hart, Oceana County, Michigan area; and systems model for the Hart power system with wind turbine.

(ECONOMICS, ENVIRONMENT)

ST77 16003 WIND TUNNEL PERFORMANCE DATA FOR THE DARRIEUS WIND TURBINE WITH NACA 0012 BLADES

Blackwell, B.F., Sheldahl, R.E., Feltz, L.V., (Sandia Labs., Albuquerque, NM), 61 p., May 1976, SAND-76-0130

Five blade configurations of a 2-meter-diameter Darrieus wind turbine have been tested in the LTV Aerospace Corporation 4.6- x 6.1-m (15- x 20-ft) Low Speed Wind Tunnel. The airfoil section for all configurations was NACA 0012. The parameters measured were torque, rotational speed, and tunnel conditions. Data are presented in the form of power coefficient as a function of tip-speed ratio for the various solidities, Reynolds number, and freestream velocities tested.

(TEST, COMPARISONS)

ST77 16004 STATUS OF THE ERDA/SANDIA 17-METRE DARRIEUS TURBINE DESIGN

Blackwell, B.F., (Sandia Labs., Albuquerque, NM), 16 p., 1976, CONF-760909-2, SAND-76-5683  
The present status of the ERDA/Sandia Laboratories 17-metre Darrieus turbine design is summarized.

(DESIGN-REVIEW)

ST77 16005 WIND TURBINE

Blackwell, B.F., Feltz, L.V., Maydew, R.C., (ERDA, Washington, DC), 9 p., Nov 11, 1975, PATENT-3 918 839, PAT-APPL-508 016, This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing, Copy of patent available Commissioner of Patents, Washington, DC, PC\$0.50

The patent relates to a wind turbine rotatable about a shaft. It may include a drive rotor with one or more elongated blades each having a central outwardly curved portion of airfoil shape which produces rotary motion when the blade rotates in wind at a blade tip velocity to wind velocity ratio greater than about three or four, additional wind rotor means disposed at both ends of the curved portions of the elongated blade for rotatably accelerating the drive rotor to the desired velocity ratio, and means coupled to said rotors for utilizing the rotation thereof.

(PATENT, BLADE-DESIGN)

ST77 16006 WIND POWER - A BIBLIOGRAPHY

Colyer, E., Su, D., (Canada Institute for Scientific and Technical Information, Ottawa, Canada), 52 p., 1975, NRC No. 14986, CNR No. 14986

This edition has resulted from the interest of many scientists at the National Research Council of Canada as well as from the researchers both in Canada, and other countries, who have found our first edition very useful. A large number of papers, reports and materials in other forms pertaining to wind power utilization have been published since our first edition which came out a year ago. However, because of the urgent demand, we could not spend as much time as we would like to locate all the materials and to include them in the present edition. Thus, errors and omission are inevitable. We sincerely hope that lapses will be reported to us so that our future editions may be better and more comprehensive.

(CANADA)

ST77 16007 LOW-COST BLADE DESIGN CONSIDERATIONS

Feltz, L.V., (Sandia Labs., Albuquerque, NM), 38 p., 1976, CONF-760551-1, SAND-76-5535

The studies described attempt to identify and continually upgrade blade designs for a 17 meter wind turbine design. The goal of this effort is to establish several low-cost blade designs.

(WIND, ECONOMICS)

ST77 16008 ELECTRICAL ENERGY OUTPUT OF WIND POWER PLANTS

Jayadevaiah, T.S., Smith, R.T., (Univ of Wisconsin, Milwaukee, WI), IEEE Ind Appl Soc, Annu Meet, 10th, Conf Rec, Atlanta, GA, Sept 28-Oct 2, 1975, Publ by IEEE, New York, NY, p. 506-511, 1975, Cat N75CHO999-31A

This paper presents a general analysis of electrical energy output of constant-speed, constant-frequency (CSCF) and variable-speed, constant-frequency (VSCF) systems based on power-duration curves. It is shown, from a sample calculation, that VSCF systems have a slight edge over CSCF systems from the point of view of energy output, but they call for large capital outlay in generating systems whereas CSCF systems call for elaborate pitch controls. It is shown that generator efficiency has a dominant influence on energy output in both the systems.

(EFFICIENCIES, COMPARISONS)

ST77 16009 WIND ENERGY STATISTICS FOR LARGE ARRAYS OF WIND TURBINES (NEW ENGLAND AND CENTRAL UNITED STATES REGIONS)

Justus, C.G., (Georgia Inst. of Tech., Atlanta, GA), NSF/RA-760191, 129 p., Aug 1976, ERDA/NSF-00547/76/1, PB-260 679/6WE

The performance characteristics have been simulated for large dispersed arrays of 500 kW - 1500 wind turbines producing power and feeding it directly into the utility distribution grid in the New England - Middle Atlantic and the Central U.S. regions. Despite comparable wind regimes in coastal New England and in the Central U.S., wind power is potentially closer to being cost-effective as a fuel saver in New England. This is because of the heavy reliance on expensive fuels in New England as compared with the Central U.S. area. By array power return time analysis, it is estimated that 24 to 48 hours of storage would increase the power reliability of 200 kW per 1500 kW generator to about 95% in New England, and to better than 95% in the Central U.S. Preliminary analysis of diurnal cycles of monthly mean winds versus time of day shows that in both New England and the Central U.S., there is a strong summertime afternoon peak in available wind, which would correspond to the summertime peak air conditioning load. The appendices included in this report are: (1) Analysis Methods, and (2) Some Aspects of Statistics of Arrays of Wind Turbines.

(RELIABILITY, ECONOMICS)

ST77 16010 DARRIEUS VERTICAL-AXIS WIND TURBINE PROGRAM AT SANDIA LABORATORIES

Kadlec, E.G., (Sandia Labs., Albuquerque, NM), 11 p., 1976, CONF-760821-7, SAND-76-5712

As part of ERDA's Federal Wind Energy Program, Sandia Laboratories is engaged in a technology development program for the Darrieus Vertical Axis Wind Turbine (VAWT). The application receiving current emphasis utilizes the VAWT operating at constant speed to generate electricity which is fed directly into a utility grid. The activities within the program are described.

(UTILITY-GRID)

ST77 16011 TOWER AND ROTOR BLADE VIBRATION TEST RESULTS FOR A 100-KILOWATT WIND TURBINE

Linscott, B.S., Shapton, W.R., Brown, D., (NASA, Lewis), NASA-TM-X-3426, E-8751, 40 p., Oct 1976, N76-33628/8WE

The predominant natural frequencies and mode shapes for the tower and the rotor blades of the ERDA-NASA 100-kW wind turbine were determined. The tests on the tower and the blades were

conducted both before and after the rotor blades and the rotating machinery were installed on top of the tower. The tower and each blade were instrumented with an accelerometer and impacted by an instrumented mass. The tower and blade structure was analyzed by means of NASTRAN, and computed values agree with the test data.

(TEST-DATA)

#### ST77 16012 OPTIMIZATION AND CHARACTERISTICS OF A SAILWING WINDMILL ROTOR

Maughmer, M.D., (Princeton Univ., NJ), NSF/RA-760201, 90 p., Mar 1976, AMS-1297, PB-259 898/5WE

Within this fourth and final quarter progress report are comprehensively discussed all of the research efforts undertaken by the Princeton windmill group over the past year. This includes a detailed accounting of the development and operational techniques of the Princeton moving-vehicle windmill testing facility. Also presented is a complete documentation of the performance build-up ( $D_p(\max) = .06$  to  $C_p(\max) = .40$ ) of a 12 ft. diameter, two-bladed Sailwing rotor. This report further includes an examination of an exploratory research effort directed toward using a small, first-stage, co-axial rotor to augment windmill performance. Finally considered are the results and conclusions of an extensive wind-tunnel test program aimed at a quantitative determination of the aerodynamic penalties associated with numerous simplifications of the basic double-membraned Sailwing cross-section.

(TEST-DATA, AERODYNAMICS)

#### ST77 16013 INVESTIGATION OF DIFFUSER-AUGMENTED WIND TURBINES. PROGRESS REPORT, JUNE 25, 1975-DECEMBER 24, 1975

Oman, R.A., Foreman, K.M., Gilbert, B.L., (Grumman Aerospace Corp., Bethpage, NY), 64 p., Jan 1976, COO-2616-1, PCS4.50/MFS3.00

The Diffuser-Augmented Wind Turbine (DAWT) is one of the more promising advanced concepts for decreasing the cost of wind energy conversion. The first results of an investigation designed to determine the most effective configurations for DAWT's and to assess their ultimate performance in large units are presented. Two types of compact diffusers have been analyzed and tested, using screens to simulate the turbines. A 20 exp 0 half-angle conical diffuser with two tangential boundary layer control slots provided a measured augmentation ratio of 1.7 at an area ratio of 2.8, while a double ring-wing diffuser gave 2.1 at an equivalent area ratio of 3.8. Results indicate potential for considerable improvement and further size reduction. Several analyses related to diffuser development are given.

(ECONOMICS, AERODYNAMICS)

#### ST77 16014 EXPERIMENTAL AND ANALYTICAL RESEARCH ON THE AERODYNAMICS OF WIND TURBINES. MID-TERM TECHNICAL REPORT, JUNE 1-DECEMBER 31, 1975

Rohrbach, C., (Hamilton Standard, Windsor Locks, CT), 111 p., Feb 1976, COO-2615-76-T-1

The successful development of reliable, cost competitive horizontal axis, propeller-type wind energy conversion systems (WECS) is strongly dependent on the availability of advanced technology for each of the system components. Past experience and current studies of this type of wind energy conversion systems have shown that the wind turbine subsystem most significantly affects the system's cost effectiveness and performance capability. Thus adequate technology bases are essential for all elements of the wind turbine design. Information is presented concerning aerodynamic design and performance technology, wind turbine parametric performance study, selection of model wind turbine configurations, and structural design of wind turbine models.

(ECONOMICS, OPTIMIZATION)

#### ST77 16015 WIND POWERED AERATION FOR REMOTE LOCATIONS

Schierholz, P.M., Somervell, W.L., Jr., Babcock, W., Hartel, R., Watson, K., (Colorado State Univ., Fort Collins, CO), NSF/RA-760238, 74 p., Apr 1976, PB-259 304/4WE

This report concerns the use of wind power directly to compress air to increase oxygen levels in polluted rivers and lakes subject to winterkill. A prime advantage may be using the water for storage of oxygen eliminating requirements for energy storage such as batteries. Three sites are proposed for the installation of wind powered systems. One is a lake chosen on the high plains for ease of access, another is a high mountain lake subject to winterkill and the third is a high plains river with pollution problems.

(WATER POLLUTION, OXYGEN-ADDITION)

#### ST77 16016 OPERATIONAL, COST, AND TECHNICAL STUDY OF LARGE WINDPOWER SYSTEMS INTEGRATED WITH EXISTING ELECTRIC UTILITY

Smith, R.T., Swanson, R.K., Johnson, C.C., Ligon, C., Lawrence, J., (Southwest Research Inst., San Antonio, TX), 7 p., 1976, CONF-760906-8

A comprehensive study of the operational, cost, and technical aspects of large windpower systems integrated with existing electric utility networks has been carried out for a region of the Texas Panhandle. The study was carried out jointly by Southwest Research Institute, Texas Tech University, Southwestern Public Service Co., and Boeing-Vertol Company.

(ECONOMICS, TEXAS)

ST77 16017 APPLICATION OF COMPOSITE BEARINGLESS ROTOR CONCEPT TO WIND TURBINE ROTOR. PROGRESS REPORT, JUNE 3, 1975-OCTOBER 31, 1975

Spierings, P.A.M., Cheney, M.C., (United Technologies Research Center, East Hartford, CT), 25 p., Dec 1, 1975, COO-2614-1, PC\$3.50/MF\$3.00

The objective of the one year program is to explore the feasibility of the Composite Bearingless Rotor (CBR) for use as a wind turbine and to evaluate several automatic control concepts designed to improve efficiency and cost effectiveness. The program consists of the design of a full-scale wind turbine, the design and fabrication of a dynamically scaled model, wind tunnel experiments, and analytical studies. To date, the design work has been completed, the model wind turbine support tower has been fabricated and assembled with a generator. The model blades and other hardware are under construction. This interim progress report contains descriptions of the full scale and model designs, a review of the performance characteristics expected of the wind turbine, and an outline of the remaining tasks of the program. Appendices are included to provide detailed information on some of the design characteristics of the model wind turbine.

(EFFICIENCIES, ECONOMICS, TEST MODEL)

ST77 16018 THE ATMOSPHERE AND THE OCEANS AS ENERGY SOURCES

Swift-Hook, D.I., (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England), In Aspects of Energy Conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975, Pergamon Press, Oxford, p. 405-429; Discussion 430 p., 1976, A77-11026 01-44, A77-11036

Wind power is discussed with emphasis on available power and sites and windmill design. Tidal power is considered with attention given to the design of tidal barrages, and engineering problems. Also considered are thermal sea power, and wave power (wave characteristics, wave power conversion devices, and overall system considerations).

(WIND, TIDAL, WAVE-POWER, OCEAN AT, OVERVIEW)

ST77 16019 WIND POWER

Syverson, C.D., (Syverson Consulting, North Mankato, MN), Design News, p. 155-160, Mar 22, 1976

Wind generators are a viable alternative energy source, one which, if properly utilized, can surely compete with the almost certain rising cost of utility power, but it is important to put it into perspective.

(POWER-OUTPUTS, EFFICIENCIES)

ST77 16020 PLANS AND STATUS OF THE NASA-LEWIS RESEARCH CENTER WIND ENERGY PROJECT

Thomas, R., Puthoff, R., Savino, J., Johnson, W., (NASA, Lewis), NASA-TM-X-71701, 31 p., 1975, CONF-7509137-1, PC A03/MF A01

The portion of the national five-year wind energy program that is being managed by the NASA-Lewis Research Center for the ERDA is described. The Lewis Research Center's Wind Power Office, its organization and plans and status are briefly described. The three major elements of the wind energy project at Lewis are the experimental 100 kW wind-turbine generator; the first generation industry-built and user-operated wind turbine generators; and the supporting research and technology tasks which are each briefly described.

(100-KW, OVERVIEW)

ST77 16021 A COMPUTER PROGRAM TO CALCULATE AND PLOT WIND-GENERATED STORED ENERGY AT CONSTANT CONSUMPTION

Valeriote, E.M.L., (Defence Research Establishment Ottawa, Ontario, Canada), 49 p., June 1976, DREO-TN-76-15, AD-A029 977/6WE, PC\$4.00/MF\$3.00

A computer program has been described which gives printed and plotted outputs of the quantity of wind-generated energy remaining in a storage system under given conditions. The program permits simulated variations of storage capacity, constant electrical load and conversion efficiency by simple data changes. Further alterations to the program itself are detailed, to adapt it to carry out similar calculations for wind turbines of various sizes of construction. The program has been tested by simulation of a hypothetical system of energy production, storage and consumption. It is planned that its predictions will be compared with data obtained from an experimental program currently in progress.

(STORAGE, SIMULATION)

ST77 16022 AERODYNAMIC PERFORMANCE OF WIND TURBINES

Wilson, R.E., Lissaman, P.B.S., Walker, S.N., (Oregon State Univ., Corvallis, OR), NSF/RA-760228, 170 p., June 1976, PB-259 089/LWE

This report summarizes the state-of-the-art of performance prediction methods for both horizontal and vertical axis wind turbines. Strip theory methods for horizontal axis wind turbines are evaluated for various tip loss models and occurrence of multiple solutions in strip theory analysis is discussed and illustrated. The performance of high-solidity turbines such as the Chalk design also are discussed. The configuration and performance of optimum horizontal axis wind turbines are addressed. Optimization schemes are developed and discussed and comparisons with the MOD-0 rotor are made. Performance at off-design conditions is also examined. Performance prediction methods for vertical axis wind turbines are covered. Chapter 4 develops the performance model for the Darrieus Rotor. Multiple solutions are found to occur for Darrieus Rotors in the same manner as occurs for horizontal axis rotors. This flow model is compared to existing experimental data and shown to yield excellent agreement. Chapter 5 contains an analytical model of the flow in a Savonius Rotor. The flow model is shown to predict the essential features of flow in Savonius Rotors with consideration of viscous effects.

(OVERVIEWS, OPTIMIZATION, MODELS)

ST77 16023 PRODUCTION OF METHANE USING OFFSHORE WIND ENERGY. FINAL REPORT

Young, R.B., Tiedemann, A.F., Jr., Marianowski, L.G., Camara, E.H., (AAI Corp., Baltimore, MD), 131 p., Nov 1975, ERDA/NSF/993-75/T1

The work accomplished during a program to investigate the feasibility of converting wind energy to methane gas is described. The basic approach consists of using off-shore winds to drive generators which supply electricity to electrolysis cells. Electrolysis of distilled sea water produces hydrogen. Carbon dioxide is derived from underwater carbonate deposits. These gases are combined to form methane. This concept offers several advantages over the generation of electrical power for insertion into an A.C. power network. It is envisioned that hydrogen will be generated at each wind turbine. Depending on the desired output of the plant, methane will be produced at each tower, or for large operations, hydrogen from many towers will be piped to a central point for processing. Here, the methane will be formed and sent to existing natural gas transmission systems.

(HYDROGEN, EFFICIENCIES)

17.000 BIOCONVERSION

ST77 17000 ENERGY FROM AGRICULTURE

Alich, J.A., Jr., Inman, R.E., (Stanford Res Inst, Menlo Park, CA), p. 287-309, 1976, Clean Fuels from Biomass, Sewage, Urban Refuse, Agric Wastes, Orlando, FL, Jan 27-30, 1976, Sponsored by Inst of Gas Technol, Chicago, IL

Under bioconversion four sources of biomass are included: urban solid waste, agricultural residues, and energy crops both terrestrial and marine. The paper concentrates on terrestrial energy crops. The types of vegetation best suited for an intensive energy plantation as well as vegetation selection criteria are discussed. The type and availability of land for, as well as logistics and economics of growing energy crops on a conceptual terrestrial plantation is discussed. An energy budget for plant material production and harvesting for the conceptual plantation is developed. A technoeconomic comparison of firing the crops directly for electric power generation with conversion to clean fuel gas either at the farm site or at selected markets is made.

(BIOCONVERSION, COMPARISONS, OVERVIEWS)

ST77 17001 ENERGY FROM AGRICULTURE - THE MOST ECONOMIC METHOD OF LARGE SCALE SOLAR ENERGY CONVERSION

Alich, J.A., Jr., Inman, R.E., (Stanford Res Inst, Menlo Park, CA), Energy, Oxford, V 1:53-61, N1, May 1976

The economics of terrestrial growth of vegetation for its energy content is far more favorable than other more technically sophisticated methods of large-scale solar energy conversion - mirrors, photovoltaics, etc. This paper summarizes the authors' view of what might be attainable in biomass production, hoping, thereby, to stimulate interest in the concept. The type of vegetation best suited for an intensive energy plantation, as well as vegetation selection criteria, are discussed. The type and availability of land for growing energy crops on a conceptual terrestrial plantation, as well as the logistics and economics, are discussed. An energy budget for plant-material production and harvesting for the conceptual plantation is developed. A technoeconomic comparison of firing the crops directly for electric power generation with conversion to clean fuel gas (methane or low-BTu gas) either at the farm site or at selected markets is made.

(BIOCONVERSION, OVERVIEWS, METHANE)



ST77 17002 BIOLOGICAL CONVERSION OF SOLAR ENERGY: AN ASSESSMENT OF ITS POTENTIAL CONTRIBUTION TO OUR ENERGY REQUIREMENTS

Boardman, N.K., (CSIRO Div of Plant Ind, Canberra, Australia), Inst of Eng, Australia; Annu Eng Conf, Townsville, May 10-14, 1976, Publ by Inst of Eng, Australia, Sydney, Pap 322/2, p. 6-10, 22 refs, 1976

The global annual productivity of terrestrial and marine plants is equivalent to stored solar energy of  $3 \times 10^{21}$  J, which is 10-fold higher than present world consumption of energy. Solar energy incident on the earth's surface is  $2 \times 10^{21}$  J per annum. Total marine photosynthetic productivity is lower than that of the land. Maximum short-term growth rates of high yielding crops represent solar energy conversion efficiencies of 2.7-4.6%. Annual productivities are considerably lower. Average forest productivities in the Northern Hemisphere represent solar energy conversion efficiencies of 0.2-0.3%. Indigenous forests in Australia have much lower productivities. At the global level, it seems unlikely that photosynthesis can provide more than a relatively small percentage of the world's energy requirements.

(BIOCONVERSION, OVERVIEWS)

ST77 17003 PHOTOSYNTHESIS AS A RESOURCE FOR ENERGY AND MATERIALS

Calvin, M., (California, University, Berkeley, CA), American Scientist, V 64:270-278, May-June 1976, ERDA-Supported Research, A77-12233

Possible ways of using the natural photosynthetic mechanisms in some plants to construct large-scale synthetic systems serving as renewable sources of materials (plastics, fibers) and fuel are examined. The processes of photosynthetic quantum collection in green plants are discussed with special attention to the photosynthetic potential of such plants as sugarcane, kelp, and the rubber tree. The possibilities of controlling natural processes in these plants and improving their energetic efficiency are analyzed. The photochemical quantum conversion in synthetic systems is then considered as a promising mechanism for direct fuel production ( $H_2$ ,  $CH_4$ , etc.). Recent studies concerning catalysts for these processes are reviewed. Particular attention is given to the problem of creating photochemical cell-membrane, in which hydrogen might be evolved on one side of the membrane and oxygen on the other. A conceptual design of such a membrane analogous to the natural chloroplast membranes is proposed.

(BIOCONVERSION, OVERVIEWS, LARGE-SCALE, RENEWABLE)

ST77 17004 MULTIDISCIPLINARY RESEARCH PROGRAM DIRECTED TOWARD UTILIZATION OF SOLAR ENERGY THROUGH BIOCONVERSION OF RENEWABLE RESOURCES. PROGRESS REPORT

Finnerty, W.R., (Georgia Univ., Athens, GA), 73 p., July 1976, SRO-888-1

Progress is reported in four research areas of solar bioconversion. The first program deals with the genetic selection of superior trees, physiological basis of vigor, tissue culture, haploid cell lines, and somatic hybridization. The second deals with the physiology of paraquat-induced oleoresin biogenesis. Separate abstracts were prepared for the other two program areas: biochemical basis of paraquat-induced oleoresin production in pines and biochemistry of methanogenesis.

(OVERVIEWS)

ST77 17005 A SOLAR-ENERGIZED SYSTEM FOR ALGOCULTURE

Fox, R.D., (Laboratoire de La Roquette, France)

A simple low-cost system for culturing the protein-rich blue-green algae, Spirulina, at the village level utilizes solar energy to produce algae, regulate temperature, provide  $CO_2$ , stir the culture, harvest the algae, and kill contaminating organisms. This system has a high potential for combatting malnutrition in the developing countries where protein deficiency is a problem.

(BIOCONVERSION, ALGAE-PRODUCTION, ECONOMICS)

ST77 17006 AGRICULTURE FOR ZERO WASTE - THE IPPI CONCEPT

Gartside, G., (CSIRO, South Melbourne, Australia), Natl Chem Eng Conf, 3rd, Proc: Treat, Recycle and Disposal of Wastes, Mildura, Victoria, Australia, Aug 20-23, 1975, Publ by Natl Chem Eng Conf, Monash Univ, Clayton, Australia, Pap T134-T136, 1 ref, 1975

The concept of Integrated Photosynthetic Product Industries (IPPI) is aimed at deriving maximum economic benefit from the resources of land and solar energy while at the same time satisfying social and environmental requirements. The project is based on the use of crops as simultaneous resources of food, energy, and consumer products. One aim of the study is efficient use of resources. The focal point of the IPPI studies is the fractionation of the plant material in such a way as to provide an acceptable input for an appropriate processing stream. Some detail is given of the fractionation studies that have been done on lucerne and kenaf.

(BIOCONVERSION, SOCIO-ENVIRONMENTAL)

ST77 17007 WASTES AND BIOMASS AS ENERGY RESOURCES: AN OVERVIEW

Klass, D.L., (Inst of Gas Technol, Chicago, IL), p. 21-58, 18 refs, 1976, Clean Fuels from Biomass, Sewage, Urban Refuse, Agric Wastes, Orlando, FL, Jan 27-30, 1976, Sponsored by Inst of Gas Technol, Chicago, IL

The national economy can be maintained on organic fuels by converting major sources of continuously renewable nonfossil carbon to synfuels that are interchangeable with, or can be substituted for, natural gas and petroleum-derived fuels. Promising sources of this carbon are waste materials, such as urban refuse, and biomass produced from solar energy by photosynthesis. The paper points out the broad scope of the technology and its potential impact on U.S. energy supplies. The renewable feature of both wastes and biomass makes them valuable "natural resources" that inevitably will be fully developed and commercialized as sources of energy-intensive products and synfuels.

(BIOCONVERSION, UNITED-STATES, SYNFUELS)

ST77 17008 CONVERSION OF OCEAN FARM KELP TO METHANE AND OTHER PRODUCTS

Leese, T.M., (Nav Weapons Cent, China Lake, CA), p. 253-266, 13 refs, 1976, Clean Fuels from Biomass, Sewage, Urban Refuse, Agric Wastes, Orlando, FL, Jan 27-30, 1976, Sponsored by Inst of Gas Technol, Chicago, IL

The paper describes a process being studied for the conversion of kelp (*Macrocystis pyrifera* - giant California kelp) into fuels. Key features of the approach are: the use of solar energy to produce biomass as a source of fuel, resulting in a stored energy to produce biomass source whose use produces no net energy increase in the earth's atmosphere; and the use of currently nonproductive ocean surface, ocean water, and deep nutrients in the production of the biomass. The current major priority of the conversion process effort is to convert the organic material in kelp to methane and utilize the resulting by-products and waste as: terrestrial fertilizer, feed supplements for meat-producing animals, and miscellaneous industrial products.

(BIOCONVERSION, OVERVIEWS)

ST77 17009 SOLAR ENERGY FOR AUSTRALIA. THE ROLE OF BIOLOGICAL CONVERSION

Morse, R.N., Siemon, J.R., (CSIRO Solar Energy Stud, Melbourne, Australia), Inst of Eng, Australia: Annu Eng Conf, Townsville, May 10-14, 1976, Publ by Inst of Eng, Australia, Sydney, Pap 322/1, p. 1-5, 18 refs, 1976

Solar energy by means of photosynthesis stores energy in trees and plants which can be converted to liquid fuel suitable for internal combustion engines. Ethanol could be produced this way from cellulose on a scale sufficient to supply half Australia's estimated needs for transportation in 2000 from forest plantations totalling 13 million ha. The process has been used on small scale, but is not fully developed. Rising energy costs will improve the prospects that research could make solar ethanol competitive with synthetic fuels such as oil from coal, and introduce a major renewable source of liquid fuel.

(BIOCONVERSION, SYNFUELS, OVERVIEWS)

ST77 17010 GAS PRODUCTION FROM MICRO ALGAE

Oswald, W.J., (Univ of California, Berkeley, CA), p. 311-324, 1976, Clean Fuels from Biomass, Sewage, Urban Refuse, Agric Wastes, Orlando, FL, Jan 27-30, 1976, Sponsored by Inst of Gas Technol, Chicago, IL

Micro algae are able to fix solar energy in the visible spectrum with daily production of 10 to 20 grams of cell material per square meter. The heat of combustion of these algae is about 5.5 kilogram calories per gram and 50 to 70 percent of this energy can be converted to methane through anaerobic fermentation of the algae. On the basis of existing technology, it appears plausible to utilize large ponds for initial fixation of energy and for transformation of the energy to methane. Most promising is an integrated solid waste and algal biogas facility in which combustion of dry wastes could be used to generate power, release carbon dioxide for algae and heat the digesters.

(BIOCONVERSION, SYSTEM-REVIEW)

ST77 17011 THE LONG-RANGE PROSPECTS FOR SOLAR-DERIVED FUELS

Pollard, W.G., American Scientist, V 64:509-513, Sept-Oct 1976, A77-12240

Solar-derived fuels are considered to be those produced annually by photosynthesis in currently growing plant material. The paper examines the potential of fuels derived from the sun through photosynthesis from the standpoint of their commercial conversion as an integral part of the world energy system in the long-range future when reserves of fossil fuels, especially petroleum and natural gas, have been depleted. Attention is focused on the pyrolysis of biomass to produce solid fuel and methanol, as well as on the production of liquid and gaseous fuels by appropriate techniques. It is shown that the long-range prospect for the use of solar energy through photosynthesis to produce solid, liquid, and gaseous fuel seems reasonably well assured. The technology for such fuels is already well developed and their extensive use awaits

a favorable price level for delivered biomass and a major shift in agricultural and silvicultural practice.

(BIOCONVERSION, OVERVIEW, CONVERSION-TECHNOLOGY)

#### ST77 17012 SOLAR ENERGY COLLECTION BY BIOCONVERSION

Sitton, O.C., Gaddy, J.L., (Missouri-Rolla, University, Rolla, MO), New York, American Institute of Chemical Engineers, V 1:91-97, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12672

The leaf system, or canopy, of a particular plant serves as a solar energy collecting surface. Efficiencies as high as 30.0 percent have been reported for the conversion of incident radiation into energy in the form of biomass. U.S. land availability for biomass production is considered, taking into account the north central cropland, crop wastes, and range and forest land. Attention is given to biomass as an energy mechanism, the processing of the biomass to obtain large quantities of methane for distribution in existing natural gas pipelines, and questions of process economics. It is found that bioconversion of plant matter to methane gas is economically attractive at today's fossil fuel energy prices. Technology and land areas are available to employ this process on a large scale today.

(ECONOMICS, UNITED-STATES)

#### ST77 17013 FEASIBILITY OF MEETING THE ENERGY NEEDS OF ARMY BASES WITH SELF-GENERATED FUELS DERIVED FROM SOLAR ENERGY PLANTATIONS (APPENDICES A, B, AND C)

Szego, G.C., (Intertechnology Corp, Warrenton, VA), 321 p., July 1976, ITC-260675-App, AD-A031 164/7WE, PC A14/MF A01  
No Abstract Available

#### ST77 17014 CLEAN FUELS FROM AGRICULTURAL AND FORESTRY WASTES

Tatom, J.W., Colcord, A.R., Knight, J.A., Elston, L.W., (Georgia Inst. of Tech., Atlanta, GA), 118 p., Apr 1976, EPA/600/2-76/090, PB-259 956/1WE

The report gives results of an experimental investigation of the operating parameters for a mobile waste conversion system based on the Georgia Tech Engineering Experiment Station's partial oxidation pyrolysis process. The object of the testing was to determine the combination of parameters producing the most char and oil and the least gas from agricultural and forestry wastes. The test indicated both the dominant influence of air/feed on char and oil yields, and the desirability of low values of this ratio. In addition to the testing, a preliminary design of a 200 ton/day mobile pyrolysis system for conversion of agricultural and forestry wastes into clean fuels was made and a simplified economic analysis conducted. The results of this work indicate the technical feasibility and the economic profitability of such a system.

(BIOCONVERSION, SYNFUELS, ECONOMICS)

#### ST77 17015 FEDERAL FUELS FROM BIOMASS ENERGY PROGRAM

Ward, R., (U.S. ERDA, Washington, DC), For Prod J, V 26:60-64, N9, 6 refs, Sept 1976

Fuel from biomass, considered an indirect form of solar energy, was identified as part of an overall solar energy program. A comprehensive 5-year program of research, development, and demonstration has been developed. The major program elements include: fuels from agricultural and forestry residues, terrestrial biomass production and conversion, marine biomass production and conversion, and basic and advanced research.

(BIOCONVERSION, SYNFUELS)

#### ST77 17016 FUEL AND ENERGY PRODUCTION BY BIOCONVERSION OF WASTE MATERIALS - STATE-OF-THE-ART

Ware, S.A., (Ebon Research Systems, Silver Springs, MD), 78 p., Aug 1976, EPA/600/2-76/148, PB-258 499/3WE

This report is a state-of-the-art summary of biological processes for converting waste cellulosic materials (agricultural, municipal and lumbering wastes) to fuels. It indicates the locations and quantities of suitable wastes and discusses the status of the current processing schemes. The processes discussed are: Acid hydrolysis followed by fermentation; enzyme hydrolysis followed by fermentation; anaerobic digestion of manure and municipal solid waste; and, biophotolysis.

(OVERVIEWS)

ST77 18000 THE IMPACT OF SOLAR HEATING AND COOLING OF HOMES ON THE ELECTRIC UTILITY

Aseltine, R., (Tennessee, University, Knoxville, TN), New York, Institute of Electrical and Electronics Engineers, Inc., p. 174-176, 1976, In Engineering in a Changing Economy; Proceedings of the Southeast Region 3 Conference, Clemson, SC, Apr 5-7, 1976, A76-47201 24-99, A76-47225

An intuitive analysis of the possible impact of solar heating and cooling of homes on the electric utility is made. Consideration is given to the load imposed by electrical backup units, and how this relates to the need for additional generation and transmission facilities. A reduction in the short term weather sensitive load through the normal operation of solar units is shown to yield a savings in daily generation costs, however, careful coordination of the various systems must be implemented for maximum efficiency.

(RESIDENTIAL, ECONOMICS, PEAK-LOADING)

ST77 18001 NEW CONCEPTS IN SOLAR PHOTOVOLTAIC ELECTRIC POWER SYSTEMS DESIGN

Federmann, E.F., Ferber, R.R., Pittman, P.F., Chowaniec, C.R., (Westinghouse Electric Corp., Pittsburgh, PA), New York, American Institute of Chemical Engineers, V 2:1308-1315, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12817

Results are presented for a study of three types of viable solar photovoltaic electric power systems. The first is an on-site residential power system with an output ranging from 1 to 10 kw; the second is an intermediate power system with an output in the range 100 kw to 10 MW for location near an industrial or commercial load; and the third is a central power system with an output varying between 50 and 1000 MW to be located remote from urban areas. The residential power system is discussed relative to system description and application, system evaluation elements, energy balance program, and system potential. The intermediate power system is examined in terms of system description, utility ownership, and proprietor-ownership. The central power system is an inseparable part of a total utility system. If one assumes that cost objectives for the photovoltaic materials are achieved, that there is an effective pre-commercialization phase, that there are rising energy costs, and that institutional problems are resolved, then the result would be widespread acceptance of all three types of systems.

(RESIDENTIAL, INDUSTRIAL-COMMERCIAL, LARGE-SCALE OVERVIEW)

ST77 18002 SOLAR POWER ROOF SHINGLE

Forestieri, A.F., Ratajczak, A.F., Sidorak, L.G., (NASA, Lewis), Dec 1975, B75-10289

A recently designed silicon solar cell module does double duty. It is designed as a roof shingle for residences and similar structures, and provides both the all-weather protection of a shingle as well as the electrical power of a solar cell module. The module consists of an array of circular silicon solar cells bonded to a fiberglass substrate roof shingle with a fluorinated ethylene propylene (FEP) encapsulant.

(RESIDENTIAL, PHOTOVOLTAIC)

ST77 18003 DEFINITION STUDY FOR PHOTOVOLTAIC RESIDENTIAL PROTOTYPE SYSTEM FINAL REPORT

Imamura, M.S., Hulstrom R., Cookson, C., Waldman, B.H., (Brooks Waldman Assoc.), Lane, R., (Martin Marietta Corp., Denver, CO), NASA-CR-135056, NAS3-19768, 303 p., MCR-76-394, ERDA/NASA-19768, N77-13533

Avail:NTIS

A parametric sensitivity study and definition of the conceptual design is presented. A computer program containing the solar irradiance, solar array, and energy balance models was developed to determine the sensitivities of solar insolation and the corresponding solar array output at five sites selected for this study as well as the performance of several solar array/battery systems. A baseline electrical configuration was chosen, and three design options were recommended. The study indicates that the most sensitive parameters are the solar insolation and the inverter efficiency. The baseline PST selected is comprised of a 133 SG M solar array, 250 ampere hour battery, one to three inverters, and a full shunt regulator to limit the upper solar array voltage. A minicomputer controlled system is recommended to provide the overall control, display, and data acquisition requirements. Architectural renderings of two photovoltaic residential concepts, one above ground and the other underground, are presented. The institutional problems were defined in the areas of legal liabilities during and after installation of the PST, labor practices, building restrictions and architectural guides, and land use.

(COMPUTER-PROGRAM, ARCHITECTURE)

ST77 18004 PERFORMANCE AND COST ANALYSIS OF PHOTOVOLTAIC POWER SYSTEMS FOR ON-SITE RESIDENTIAL APPLICATIONS

Kirpich, A., Shepard, N.F., Jr., Irwin, S.E., (General Electric Co., Space Div., Valley Forge, PA), New York, American Institute of Chemical Engineers, V 2:1300-1307, 1976, In Intersociety

Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12816

Results are presented for the performance analysis of an on-site residential photovoltaic power system, both with and without energy storage. For systems with energy storage, a direct (or float) charge system implementation with a lead-acid battery was selected, whereas for systems without energy storage a maximum power tracking DC/AC inverter was used to provide the interface between the solar array and the utility. The system performance sensitivity to the number of solar cells in the array and to the solar roof slope angle is discussed. The results of system performance calibrations for the battery and no-battery cases are used as a basis for a modified present worth cost analysis to determine the preferred system sizing associated with the minimum cost of energy supplied. Major conclusions are that for average size all-electric houses on-site residence photovoltaic systems with energy storage can achieve energy displacements varying from 38 to 80% for the range of U.S. weather conditions, and that systems without energy storage can achieve energy displacements ranging from 51 to 98%.

(ECONOMICS, STORAGE)

ST77 18005 COMPOSITE RESIDENTIAL POWER SUPPLY SYSTEMS - A PROJECTION - ALTERNATE DOMESTIC ENERGY SOURCES

Patterson, W.B., (USAF, Space and Missile Test Center, Vandenberg AFB, CA), American Institute of Aeronautics and Astronautics, Inc., Vandenberg, CA, Western Periodicals Co., North Hollywood, CA, p. 49-57, 1976, In Symposium on Alternate Fuel Resources, Santa Maria, CA, Mar 25-27, 1976, Proceedings, A76-47287 24-44, A76-47292

The paper presents a brief survey of alternate energy sources, with special emphasis on small-scale solar energy sources. Energy sources are discussed relative to capital sources (petroleum, coal, etc.), controlled fusion processes, renewable sources (hydroelectric, geothermal, tidal, etc.), and solar energy (photocells, focused collectors, and flat-plate collectors). Heating and cooling applications of solar energy are indicated. The main reason for the decline of solar water heaters is reported to be a strong promotion campaign to have everyone switch to utility-powered water heaters. The main areas of action should be to educate the public concerning solar energy and to take steps to make its use economical.

(COMPARISONS, SOCIO-ECONOMICS)

ST77 18006 AN INTEGRATED PHOTOVOLTAIC/THERMAL HIGH INTENSITY SOLAR ENERGY SYSTEM (HISES) CONCEPT FOR RESIDENTIAL APPLICATIONS

Sater, B.L., Goradia, C., (Cleveland State University, Cleveland, OH), New York, American Institute of Chemical Engineers, V 2:1316-1323, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44 A77-12818

An integrated photovoltaic/thermal high intensity solar energy system (HISES) concept is presented for residential application. The design of a 36 Sq m HISES which can supply almost the entire energy for the heating, air conditioning, hot water and electrical needs of an 1800 Sq ft model home in Albuquerque, NM is discussed in detail. It appears that the HISES concept can be implemented in the very near future and that it is cost effective in terms of both dollar value and energy payback. At an installation rate of about 500,000 HISES per year, a 36 Sq m HISES is estimated to cost less than \$4,500, while providing over 45,000 kwhr/yr of thermal energy at \$0.0072/kwhr and over 10,000 kwhr/yr of electrical energy at \$0.02/kwhr and resulting in an equivalent fuel savings of over 30 million barrels of oil total per year.

(ECONOMICS)

ST77 18007 DEFINITION STUDY FOR PHOTOVOLTAIC RESIDENTIAL PROTOTYPE SYSTEM

Shepard, N.F., Landes, R., Kornrumpf, W.P., (General Electric Co., Philadelphia, PA), NASA-CR-135039, NAS3-19769, 271 p., DOC-76SDS4225, N77-13532  
Avail:NTIS

A site evaluation was performed to assess the relative merits of different regions of the country in terms of the suitability for experimental photovoltaic powered residences. Eight sites were selected based on evaluation criteria which included population, photovoltaic systems performance and the cost of electrical energy. A parametric sensitivity analysis was performed for four selected site locations. Analytical models were developed for four different power system implementation approaches. Using the model which represents a direct (or float) charge system implementation the performance sensitivity to the following parameter variations is reported (1) solar roof slope angle; (2) ratio of the number of series cells in the solar array to the number of series cells in the lead-acid battery; and (3) battery size. For a Cleveland site location, a system with no on site energy storage and with a maximum power tracking inverter which feeds back excess power to the utility was shown to have 19 percent greater net system output than the second place system. The experiment test plan is described. The load control and data acquisition system and the data display panel for the residence are discussed.

(SITE COMPARISONS, MATHEMATICAL MODELS, UTILITY-INTEGRATION)

ST77 19000 EXPERIMENTS ON SOLAR PHOTOVOLTAIC POWER GENERATION USING CONCENTRATOR AND LIQUID COOLING

Beam, B.H., Hansen, C.F., (Beam Eng Inc, Sunnyvale, CA), Conf Rec of the IEEE Photovoltaic Spec Conf, 11th, Scottsdale, AZ, May 6-8, 1975, Publ by IEEE, New York, NY, p. 332-337, 1975, Cat N75CH0948-OED

Calculations and experimental data are presented leading to the development of a practical, economical solar photovoltaic power supply. The concept involves concentration of sunlight up to about 100 times normal solar intensity in a solar tracking collector and directing this to an array of solar cells. The cells are immersed in water circulated from a thermal reservoir which limits cell temperature rise to about 20°C above ambient during the day and which cools to ambient temperature during the night. Experiments were conducted on solar cells using a Fresnel lens for magnification, a telescope equatorial mount with clock drive, and tap water circulated through the solar cell holder cavity. Test results show that cells operate satisfactorily under these conditions. Power outputs achieved experimentally with cell optimized for 25 suns were linear with concentration to about 15 suns. Cells optimized for 100 suns were not available, but a corresponding linear relation of power output with concentration is anticipated. Test results have been used in a design analysis of the cost of systems utilizing this technique.

(TEST-DATA, SYSTEM-REVIEW)

ST77 19001 PERFORMANCE OF SILICON SOLAR CELLS UNDER CONCENTRATION

Bell, R.O., Ho, J.C.T., Kurth, W.T., (Mobil Tyco Solar Energy Corp., Waltham, MA), Electrochemical Society, Inc., Princeton, NJ, p. 237-263, 1976, In International Symposium on Solar Energy, Washington, DC, May 5-7, 1976, Proceedings, A76-47051 24-44, A76-47067

Generally solar cells have been designed and fabricated to work with unit solar flux. A cell optimized for such conditions definitely is not best for use under concentration. A theoretical model of a Si solar cell was developed to help with this optimization and then compared to experimental measurements made on commercial state-of-the-art cells at concentrations between 1 and 10 suns. Such moderate concentrations are those encountered for collectors such as the side mirror reflector, linear Fresnel lens or compound parabolic collector which do not require diurnal tracking. The excellent agreement with theory encourages us to believe the model is useful in predicting performance under concentration for guidance in improving the design.

(PHOTOVOLTAICS, DESIGN-REVIEW)

ST77 19002 CONVERSION OF SOLAR ENERGY BY PHOTOSYNTHESIS TO OBTAIN MOLECULAR HYDROGEN

Berezin, I.V., Varfolomeev, S.D., (State Univ im. M. V. Lomonosov, Moscow, USSR), Geliotekhnika, p. 60-73, N3, 25 refs, 1976, In Russian

A general survey is given of the state of the art of hydrogen production from water by photosynthesis using solar energy. Soviet and foreign research results are summed up.

(OVERVIEW, SOVIET-UNION)

ST77 19003 SOLAR ENERGY CONVERSION - THE CHEMICAL VIEWPOINT

Boer, K.W., (Delaware, University, Newark, DE), Resource Recovery and Conservation, V 2:5-21, Aug 1976, A76-47695

The paper reviews solar energy conversion technology with attention given to photochemical reactions (bioconversion to fuels, and thermochemistry), direct conversion of sunlight into electricity (thermoelectric and photovoltaic conversion). The solar one concept of deploying solar cells for heat and electricity is illustrated by the example of the Delaware solar one house. Economic aspects of solar energy conversion are discussed and schedules are presented for possible large scale deployment.

(PHOTOVOLTAICS, HEAT-REJECTION, ECONOMICS, OVERVIEWS)

ST77 19004 ON HEAT REJECTION FROM TERRESTRIAL SOLAR CELL ARRAYS WITH SUNLIGHT CONCENTRATION

Florschuetz, L.W., (Arizona State Univ, Tempe, AZ), Conf Rec of the IEEE Photovoltaic Spec Conf, 11th, Scottsdale, AZ, May 6-8, 1975, Publ by IEEE, New York, NY, p. 318-326, 1975, Cat N75CH0948-OED

A simple model for preliminary assessment of cooling system requirements for heat rejection from solar cells subjected to concentrated solar irradiation levels is presented, based on an effective thermal conductance concept. Several basic passive and active cooling schemes are analyzed, and representative effective thermal conductance values determined. Results show that passive cooling to ambient air with extended surfaces can accommodate irradiation levels achievable with practical linear or trough type concentrators, but performance will depend on adequate local wind characteristics. Once through forced cooling with ambient air is not a viable

alternative. For irradiation levels typical of paraboloid concentrators, appropriate types of water cooling should be adequate.

(PHOTOVOLTAICS, COOLING-SYSTEMS)

ST77 19005 HYDROGEN SEPARATION AND COMPRESSION THROUGH HYDRIDE FORMATION AND DISSOCIATION BY LOW-LEVEL HEAT

Gidaspow, D., Liu, Y., (Institute of Gas Technology, Chicago, IL), New York, American Institute of Chemical Engineers, V 1:920-925, 1976, In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nevada, Sept 12-17, 1976, Proceedings, A77-12662 02-44, A77-12770

A process making it possible to effect hydrogen separation from methane and compression of hydrogen into hydrides, using low-level heat (waste heat, or solar energy from flat plate collectors) and eliminating an expensive cryogenic separation step, is described. The hydrogen product stream can be delivered at pressures up to 1000 PSIG, with methane, CO<sub>2</sub>, and N<sub>2</sub> removed. Alloys of Fe-Ti, Fe-Ti-Ni, and LaNi<sub>5</sub> are proposed as sorbents in the separation step. Hydrogen production from biomass partially oxidized with air is considered, as well as hydrogen removal from methane-hydrogen mixtures resulting in coal gasification processes or from coal gases produced by in situ coal gasification processes, for production of pipeline quality gas without a cryoseparation step.

(OVERVIEW)

ST77 19006 PHOTOVOLTAICS AND BIOMASS UTILIZATION

Johnson, A.C., (MITRE Corp., Bedford, MA), Washington, DC, Government Institutes, Inc., p. 158-162, 1976, In Energy Technology III - Commercialization; Proceedings of the Third Conference, Washington, DC, Mar 29-31, 1976, A76-45226 23-44, A76-45240

The direct conversion of sunlight into electricity by photovoltaic cells, and the production of heat or fuels from organic wastes or from land or water crops grown for energy purposes, are two applications of solar energy which offer considerable promise for the midterm. Research, development and demonstration can produce more efficient and reliable photovoltaic systems and better production methods; more efficient biomass production, collection and conversion processes; and optimized systems for the utilization of both these energy sources.

(BIOCONVERSION, OVERVIEWS)

ST77 19007 PRIMARY ENERGY SOURCES FOR HYDROGEN PRODUCTION

Marchetti, C., (International Institute of Applied Systems Analysis, Laxenburg, Austria), Revue De L'Energie, V 27:102-112, Feb 1976, A77-11335, In English and French

Various blue-sky approaches to production of hydrogen by novel low-cost thermodynamically efficient processes with ecological compatibility are put forth. Tapping of hydrogen stored in trees by using genetically engineered microflora and suitable collectors, secondary recovery of coal, an energy-island concept of using nuclear fission reactors in hydrogen production at terawatt levels, hydrogen extraction from thermonuclear plasma, tapping solar energy by developing photothermal chemistry techniques and appropriate semiconductors and solid electrolytes, and tapping melting glacier ice and ocean thermal gradients are considered. The storability, transportability, flexibility, and ecological compatibility of hydrogen and the ecological safety of associated electrolytic processes are pointed out.

(PHOTOTHERMAL-CONVERSION, OCEAN AT)

ST77 19008 A SURVEY OF HYDROGEN PRODUCING PHOTOSYNTHETIC ORGANISMS IN TROPICAL AND SUBTROPICAL MARINE ENVIRONMENTS

Mitsui, A., (Rosenstiel School of Marine and Atmospheric Science, Miami, FL), NSF/RA-760203, 73 p., 1976, PB-259 212/9WE

The research is concerned with the concept of converting solar radiation into a usable fuel, or other product, via a biological conversion system. The study examines the feasibility of exploiting the natural hydrogen gas producing capability of marine photosynthetic microorganisms as a source of fuel for the future. Included is a review of the working hypothesis and the progress made within the first of this two-year plan aimed at estimating the possibility of commercial applications of this concept. The most significant result of the first year's experimentation is the discovery of a blue-green algal species with remarkably high and stable hydrogen photoproduction capability. The discovery of such a strain provides numerous opportunities for further research and application. Subsequent to these experiments, it will now be feasible to conceive of designing a prototype hydrogen production plant, at least on a laboratory scale.

(OVERVIEWS)



ST77 19009 HYDROGEN PRODUCTION USING SOLAR RADIATION

Ohta, T., (Yokohama National University, Yokohama, Japan), Veziroglu, T.N., (Miami, University, Coral Gables, FL), International Journal of Hydrogen Energy, V 1:255-263, Oct 20, 1976, A77-13540

Various water-splitting methods using solar energy are reviewed and compared to each other. Direct thermal method has the highest efficiency, however it poses difficulties because of the need for heat-resisting materials. Thermochemical method becomes promising if corrosion-resisting materials are found. Electrolytic method is straightforward and conventional. However, a hybrid system combining electrolytic method with thermochemical and/or photochemical methods looks promising and is believed to result in optimum conversion efficiencies in the near future. Photolysis and biochemical methods are environmentally most acceptable, but are of low conversion efficiencies presently.

(PHOTOTHERMAL-CONVERSION, COMPARISONS)

ST77 19010 HIGH INTENSITY SOLAR CELL - KEY TO LOW COST PHOTOVOLTAIC POWER

Sater, B.L., Goradia, C., (NASA, Lewis), Conf Rec of the IEEE Photovoltaic Spec Conf, 11th, Scottsdale, AZ, May 6-8, 1975, Publ by IEEE, New York, NY, p. 356-363, 15 refs, 1975, Cat N75CH0948-OED

This paper discusses the problems associated with conventional solar cells at high intensities and presents the design considerations and performance characteristics of the "high intensity" (HI) solar cell which appears to eliminate the major problems. Test data obtained at greater than 250 air mass one (AM1) suns gave a peak output power density of 2 w/cm<sup>2</sup> at an efficiency exceeding 6% with an unoptimized cell operating at over 100°C. It appears that operation at 1000 AM1 suns at efficiencies greater than 10% is possible. At 1000 AM1 suns and 10% efficiency, the HI cell manufacturing cost is estimated to be \$0.25/watt, with multi-megawatt annual production capability already existing within the industrial sector. A high intensity solar system was analyzed to determine its cost effectiveness and to assess the benefits of further improving HI cell efficiency. It appears that residential sized systems could be produced at less than \$1000/kw peak electric power with substantial amounts of thermal energy available for heating and cooling. Because of their superior high intensity performance characteristics compared to the conventional and vertical multijunction cells, HI cells and light concentrators may be the key to low cost photovoltaic power.

(ECONOMICS, RESIDENTIAL, HEATING)



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